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DISTANCE EDUCATION: A PROGRAM AND FACILITY STUDY

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DISTANCE EDUCATION: A PROGRAM AND FACILITY STUDY

Prepared for the Distance Learning in Small Schools Project
by

HSP Humanité Services Planning Ltd.
under contract to
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PREFACE

Technology is becoming an increasingly important component of both distance education and education in general. This study was initiated in response to two needs: the immediate need of a number of Alberta's small schools in the Distance Learning in Small Schools Project that were experimenting with provision of a broadened range of course offerings through distance education and a need for specifications for regular educational facilities designed to accommodate technologically-enhanced management and delivery of instruction and learning resources.

This publication, Distance Education: A Program and Facility Study, provides both a review of the different technology modes that may be used for distance education and a set of guidelines for planning and developing conceptual designs for educational facilities capable of supporting technologically-enhanced educational delivery systems in a variety of settings.

The study was completed by Malcolm Holt, partner in charge of the project for Humanité Services Planning Ltd., and aided by Slyvia Mentz, Research Assistant, and James Donelon, Technology Consultant.

Guidance during the project was provided by a Steering Committee with the following members:

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Comments and suggestions on the contents of this report are welcomed by Alberta Education.

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EXECUTIVE SUMMARY

The ultimate goal of this study is to provide conceptual/schematic designs for distance education facilities, including schools participating in the Distance Learning in Small Schools Project. Traditionally, physical distance has been the only intermediary between teacher and student in a distant learning situation. Today, however, technology is becoming an increasingly significant component of the distance education suite. Thus, inherent and central to this study's purpose is incorporation of different technology modes meeting different instructional requirements. However, while technology mitigates the distance between instructional source and student, it also creates pedagogical concerns which must be addressed.

To determine appropriate modes of technology and identify associated concerns, participants in the Distance Learning in Small Schools Project and other experts were interviewed. A survey of the current literature on distance education identified five major areas of investigation which interviewees were asked to address:

- aims of distance education,
- appropriate technology modes,
- design considerations,
- relationships between the distance education suite and adjacent instructional areas,
- human communications (i.e. effect on education paradigm, role of teacher, attitudes/behaviours of teachers and students).

Recent literature was also examined to determine current thinking on these topics. Although distance education has been addressed in a growing body of literature since the mid 1970s, the search conducted for this study focused on publications from 1985 to the present, because the research is extensive and technological developments are advancing rapidly.

Technology pervades today's society, and much of it originally developed for business and industry has been successfully adapted for educational purposes. Among the advantages of using technology are its suitability for individualization of the learning process; it can assure equitable access by all students, however remote their locations, to quality learning opportunities and information resources; and it can be effective in increasing the student's motivation to learn. On the other hand, a technology-based learning environment is complex and can separate students from each other and from their teachers. These factors and a multitude of other issues suggest that technology isolated from pedagogical and economic considerations will not meet the challenge of serving the remote learner equitably. The appropriate mix of courseware must be selected to satisfy instructional objectives, followed by choice of hardware.

Since different schools will likely choose different combinations of technology modes to meet specific needs, flexible planning modules are presented in this report. General planning and design considerations, applicable to all situations, are pro-

EXECUTIVE SUMMARY (cont'd)

vided for the distance education suite and for the student workstations within it. Two workstation planning modules (Types A & B) accommodate ten different technology modes for individual instruction. Spatial relationships between areas for the teacher, workstations, assignment completion, and storage have been calculated and are illustrated. Construction costs for these design modules are based on the estimated *premiums* (i.e. additional costs) associated with a high-tech lab. Two estimated costs provide two points on a sliding scale, from which costs of other suites can be calculated by interpolation.

What does the future hold for distance education? While this report outlines the most current of educational technologies, the reader must be cognizant of the rapidly-changing technological environment. Choices must be made carefully, because the technology described here might be obsolete within a few years. On the other hand, some technology currently feasible in large urban areas (e.g. fiber optics) may not be a reality in rural Alberta for another decade. Cost, too, may prohibit implementation of otherwise appropriate technology modes. However, we are justified in being optimistic about the future. Eventually students in remote areas of the Province, as well as their urban peers, might conceivably have access to the most sophisticated information resources and learning experiences through global data networks.

GLOSSARY

Analogue: A continuous signal that varies in pitch and amplitude. It must be recorded and broadcast as a continuous signal unless it is coded as digital information (Hudspeth & Brey, p.195).

Audio Tape: A tape recording of sound. Information can be added to the tape or changed.

Baud: Indicates the transmission rate of digital information over a telecommunication system. One baud equals one bit per second (Hudspeth & Brey, p.195).

Bit (Binary Digit): A unit of computer information equivalent to the result of a choice between two alternatives (as *yes* or *no*, *on* or *off*) (*Webster's Ninth New Collegiate Dictionary*). This digit is restricted to two values, 0 or 1.

Byte: Each group of eight adjacent bits is called a *byte* .

Cable Television: A communication system that relies primarily on a coaxial cable to deliver information to subscribers. Early cable systems were used only for television programs. Newer systems may carry a variety of information services and can be interactive or two-way (Hudspeth & Brey, p.195).

CD ROM (Compact Disc Read Only Memory): A disc which is encoded with picture and sound and uses laser technology to store information in a form similar to that used by compact discs. It greatly increases the amount of information available locally on-line. Presently, this technology is "read only" (information cannot be added or changed), but it is expected that the future will yield a "read - write" product.

Coaxial Cable: A transmission line that consists of a tube of electrically conducting material surrounding a central conductor held in place by insulators and that is used to transmit telegraph, telephone and television signals of high frequency (*Webster's Ninth New Collegiate Dictionary*).

Compact Disc: A plastic disc, approximately 11.5 mm in diameter, holding unchangeable digitized information which is decoded and converted into sound by means of a compact disc player.

Computer Assisted Instruction (CAI): Continuous interaction of the learner with a computer for the purpose of learning new material, drilling previously-learned material, or modelling (simulating) real-world phenomena (*Organizing Distance Education Alternatives*, p.191).

Computer Conferencing: Communication (usually asynchronous) among several users of a "host" computer. All comments can be read by all participants in the discussion (*Organizing Distance Education Alternatives*, p.179).

Computer Managed Instruction (CMI): A data-based record system organized around major topics of a course (units, modules, lessons), such that personnel and distribution of materials can be scheduled, student progress monitored and assessment and evaluation data processed for reports and grading (Hudspeth & Brey, p.81).

Computer Managed Learning (CML): Refers to the use of the computer to diagnose the learner's strengths and weaknesses and to direct him/her to appropriate learning materials. The computer is used for testing rather than teaching (*Organizing Distance Education Alternatives*, p.181).

Convenor: A device used in a teleconferencing situation. It contains a speaker and some switching circuitry, which are connected to the telephone system. Attached to the convenor are microphones into which students can speak.

Courseware: Refers to all materials such as books, videotapes, compact discs, etc. required by a student to complete a course of study.

Database: Simply stated, a database comprises information in a computer's memory. There are two types of databases. On-line databases are continually updated to provide information on rapidly-changing subjects such as currency exchange values and stock market quotes. Relatively unchanging databases can be distributed in a permanent physical form, such as an optical or magnetic disc (*Communications Canada*, p.26).

Database Services: Customers can browse through a wide variety of databases to assist them in accessing information on everything from stock market quotations and legal precedents to football scores and movie reviews (*Communications Canada*, p.53).

Digitization: Messages are coded for transmission in the digital language of computers as a series of zeroes and ones, instead of in wave or analogue form (*Communications Canada*, p.36).

Digitizing Tablet: Valuable input device for Computer-Aided Design/Computer-Aided Manufacturing (CAD/CAM). It can function with a limited range of other software.

Distance Education: Formal or nonformal instructional situations where learning takes place at sites removed from the point of origination and is characterized by varied degrees of access to the teacher, tutor or peers. Today, instruction is often mediated by technology as well as by physical distance (Zigerell, p.55).

Downlink: A ground station that can receive a satellite broadcast signal. This station requires a special antenna, usually dish-shaped, to collect the weak high frequency transmission of a satellite (Hudspeth & Brey, p.196).

Electronic Bulletin Board: Part of an electronic mail system that allows users to "post" messages accessible to all network participants (Zigerell, p.55).

Electronic Mail (E-Mail): Messages composed on personal computers or specially designed telephone sets incorporating video screens and keyboards are "posted" either directly to other terminals or to "mailboxes" located in a central computer's memory (*Communications Canada*, p.53).

Facsimile Transfer (FAX): A printing device which permits bidirectional transfer of hard copy over large distances. Currently, FAX is primarily stand-alone technology, but recent developments accommodate a FAX modem hooked directly to a computer, which is then able to act like a FAX machine.

Fiber Optics: A telecommunications system that transmits pulses of light through hair-thin glass or plastic fibers (Zigerell, p.55).

Hard Copy: Information that can be taken away from a computer in permanent form, e.g. text printed on paper.

Hypertext: Currently, the newest of software technologies. Large amounts of information can be arranged in different relationships by the user. Different types of data can be related in an unlimited number of combinations. Thus different forms of information (graphics, text, databases and applications) may be retrieved in a single software environment.

I-Net (Institutional Network): A separate communication system, relying primarily on cable, which connects selected sites such as schools, colleges and government agencies. The I-Net is usually two-way and may carry television plus voice and high-speed data channels (Hudspeth & Brey, p.196).

Interactive Television: A form of cable TV that allows subscribers/viewers to send as well as receive information by means of a keypad or keyboard. Viewers may respond to questions posed by an instructor (Zigerell, p.55).

Interactive Video: A microcomputer tied to a videotape or disc player so that the learner can interact with still, motion or computer-generated lesson material (Hudspeth & Brey, p.196).

Megabyte: 1,048,576 bytes (see *bit* and *byte*) (*Webster's Ninth New Collegiate Dictionary*).

Microwave: Point-to-point very high frequency signal distribution that uses line-of-sight transmitting and receiving "dishes." These systems may serve to feed parts of a cable system within a city, to connect closed circuit systems and/or to connect cities. Typically, microwave will carry one television signal plus a small number of audio and data channels or a large number of data channels (Hudspeth & Brey, p.197).

Modem: Converts electronic signals so that they are compatible with the equipment being used. For example, a modem is required to modify the signal generated by a computer to a form suitable for transmission over telephone lines.

Multiplexer: Allows for simultaneous transmission of serveral messages on the same circuit or channel.

Packet Switching Networks: Provide world-wide access to information by acting as gateways to information utilities and other packet switching networks. These networks are excellent for computer conferencing.

Satellite: The space device used to accept and rebroadcast communication signals such as data and television programs (Hudspeth & Brey, p.197).

Simulation: A mode of learning whereby knowledge and understanding are acquired not by direct experimentation, but by means of an imitative device or process. For example, students can engage in problem-solving and decision-making processes via a computer and appropriate software.

Software: Generally refers to computer programs, which fall into two broad categories: systems and applications software. Systems software refers to that programming which directs the fundamental operations of a computer. Applications software operates in conjunction with systems software by providing the necessary programming to undertake specific business management, education or other applications (*Communications Canada*, p.36). In more recent usage, the term *software* also describes resources (such as audio tapes, video tapes and compact discs) which provide information to the student. Used in this way, the term is related to *courseware*.

Teacher Aid, Teacher Intern or Facilitator: During this study, these terms were used by educators to denote persons on-site in a distance education suite. Their role includes monitoring equipment and student progress, and motivating and generally assisting students. They are not the traditional subject specialists or imparters of knowledge.

Teacher, Tutor/Marker or Subject Specialist: During this study, these terms were used by educators to define teachers remote from the distance education suite. Their role includes imparting knowledge and providing feedback on student progress by using technology modes.

Teleconferencing: Bringing together by electronic means three or more people in two or more locations to share a commmon discussion (Robertson, p.122). Audio teleconferencing permits different parties to speak to one another. Video teleconferencing can be one-way video/two-way audio, where only the teacher is visible to the students, or two-way video/audio.

Telephone Bridge: An electronic device that ties two or more telephone lines together so that individuals can hold a teleconference. More advanced bridges automatically connect and provide constant volume for all callers (Hudspeth & Brey, p.198).

Telewriter: Used with a microcomputer over telephonic communications systems to send and receive signals and produce hard copy from them. Used to enhance audio teleconferencing as a desk top device. As each participant writes on the tablet or types on the computer keyboard, the results are displayed on all of the screens in the network simultaneously and instantaneously.

Uplink: A ground station that transmits a signal to a satellite for retransmission to ground stations (Hudspeth & Brey, p.199).

Videodisc: A plastic disc, similar in size and shape to a phonograph record, which is encoded with picture and sound for playback over a television set (Zigerell, p.56).

Video Tape: A tape recording of sound and images. This is generally a stand-alone technology but can be integrated with a computer. Information can be added to the tape or changed.

Videotex (Videodata or Telidon): A class of interactive technologies whereby textual and graphic information is called up from a centralized computer via keyboard or keypad for display on a television set or computer terminal. The telecommunications connection may be by phone line or cable. Some classification systems refer to such interactive systems as *viewdata*. The term *videotext* is then used to encompass both viewdata and teletext, a related technology in which the viewer chooses from a more limited range of information and does not interact with the central computer (Zigerell, p.56).

Voice Mail: Spoken messages are recorded in digital code and stored in computer memory until they can be retrieved by the independent recipient (*Communications Canada*, p.53).

VSAT (Very Small Aperture Terminals): Small, low-cost satellite earth stations that are used in data communication networking. This technology provides a data communication alternative for a particular networking situation: medium-to-large, wide-area networks (Highsmith, p.57).

Workstation: A student work area providing more space than a standard student desk and accommodating an array of electronic equipment. A workstation will likely include a monitor, keyboard and writing area.

1. INTRODUCTION

Distance Education: Definitions

Various definitions of distance education emphasize different aspects of the process. For example, Benson and Hirschen (1987) offer that long distance learning "refers to instruction that originates at a site distant from that of the learners." Similarly, Watson et al. (1987) define the process as "learning which comes from afar." Cropley and Kahl (1986), however, stress the individual mode of learning when they define "the single definitive characteristic of distance education" as the absence of direct contact between teacher and learner and among learners. Holmberg (1985) mitigates this definition somewhat by defining distance learners as those who do not benefit from continuous and immediate supervision by instructors. Inherent in all of these definitions today are, of course, technological innovations to facilitate learning from distant sources.

Effect of Educational Technology:

Technology is the focus of this study, which is ultimately concerned with providing conceptual/schematic designs for distance education facilities within schools participating in the Distance Learning in Small Schools project. The most-often cited justification for distance education in this province is to maintain the viability of small rural high schools through equitable access by all students to a quality education. These schools can remain open only if they provide the range and quality of services students need and desire. While students might be bussed to larger centres, educators interviewed for this study indicated that, with declining rural populations, the quality of a student's life is affected if s/he is bussed for too long a period each day. This factor, along with the resistance of the public to school closure, salary expenses, and the difficulty of attracting qualified teachers to remote areas, makes technology a highly desirable service delivery alternative.

Technology is cited as a means of making small rural schools viable.

Factors currently militating against rural schools.

While neither distance education nor the use of technology for educational purposes are recent innovations, many of the technology modes currently in use and on the horizon *are* innovative. The literature acknowledges that utilization of technology is accompanied by a concomitant shift in how information is acquired and in the type of learning which occurs: "Education is shifting paradigms from how much or what a person knows to what a person knows plus the ability to reorganize and structure mental functioning" (Pea, 1985; cited by Watson et al., 1987). As the technological tools become more sophisticated, the impact on the educational process will become more profound. The educational delivery system will shift from group instruction where a "uniformly-sized cohort of students" (Hathaway, 1980) is studying the same material at the same time, to an individualized mode of instruction which meets the specific needs of each student.

Technology is creating shifts in paradigms and the educational delivery system.

Advantages of Educational Technology: i. Individualization

The learning process can become more individualized

Precisely this individualization of the learning process is most often cited as the primary advantage of technology-based instruction, which is proposed as a major component of distance education. Acceding that a number of different educational theories, rather than a single philosophy, form the basis of distance education, Purdy (1986) states that, generally, distance education has been built on an individualist theory of knowledge and education. This statement is corroborated by Turnbull (1986) who notes that "one of the primary strengths of distance education is its student-centered approach to learning." For example, students can proceed at their own pace, and differing learning styles can be accommodated by the many resources made available by technology's educational tools. This flexibility can enhance students' self-confidence and allow them to take responsibility for their learning.

Students can learn at their own pace.

ii. Equal Access and Availability

Niemi and Gooler (1987) list other benefits provided by instructional technologies: access to learning opportunities and availability of better information resources. Allowing all students equal access to high-quality programs helps fulfill the aims of an education system. According to Sheppard (1986), "for education in all contexts, the aim is to bring equality of opportunity." Not only can technology surmount difficulties posed by remote geographical areas, it can increase the information available to students and enrich their learning process. Computers, for example, can provide innovative learning experiences, and integrated technologies make possible almost limitless information sources. As Turnbull (1987) notes, "in this era of geography-indifferent technologies, accessibility and the quality of the interaction between the student and the teaching institution is improving significantly."

All students can have equal access to quality programs.

iii. Increased Motivation

Increased motivation to learn is another benefit ascribed to technology by Niemi and Gooler (1987). These authors indicate that technology can make learning "more exciting, interesting, and meaningful." Their discussion, however, is concerned with adult learners and, as such, does not consider that younger students and children may not be quite as enamored of high-tech equipment. An interviewee noted that many children are saturated with routine exposure to television, audio and video cassettes, and computers. As a result, they may appreciate more traditional modes of learning and human interaction in the classroom. However, with the very rapid and ongoing advancements in computer technology, interactive electronic learning modes are becoming increasingly feasible instructional alternatives.

Technology increases motivation.

Critical Factors:
i Human Interaction

The paucity of human interaction in a technology-based learning environment is cited frequently as a major disadvantage: "Teachers involved in distance education identify their greatest problem as the gap in personal interaction with their students" (Sheppard, 1986). Purdy (1986), too, states that "the greatest problem with telecourse instruction is that it tends to separate the teacher from students and students from other students, thus impersonalizing the educational process." A number of authors caution that technology alone is not a suitable substitute for teachers. For example, Watson, Calvert and Collins (1987) "maintain that the best way for a human to learn is from another human and that electronic learning will always be secondary, but of increasing significance." Sheppard (1986) also concludes that "technologies should be used to enhance, not to replace, the personal contact between teachers and students in distance education."

Technology tends to separate the teacher from the students.

What are the implications of these statements for delivery of education in rural Alberta? Obviously, teachers with specialized knowledge cannot be hired to serve only two or three students requiring instruction in a particular subject. The answer is not to eliminate the role of the teacher, but rather to change it. While teachers are traditionally imparters of knowledge, technology-based delivery requires them to become managers of the learning process and student motivators. They will change from "keepers of the subject matter knowledge to learning directors, coaches, contractors and diagnosticians" (Watson, Calvert and Collins, 1987). Such a role, assumed by teachers on-site, is not necessarily suited to the subject specialist, who may instead be located at a site remote from the students. The subject specialist may ideally become the tutor/marker who uses technology to answer students' questions and provide feedback on performance. More direct human interaction could still be provided by persons on-site, persons responsible for monitoring both the students and the equipment within a distance education suite. Educators interviewed during the course of this study suggested that such a role might be appropriately assumed by teacher interns or aides.

The role of the teacher will change.

ii. Planning

Planning for technology-based instruction is important.

The importance of human interaction to facilitate learning underscores the fact that technology alone does not provide the solution for serving students in remote areas. Sheppard (1986) maintains that "communications technology should be regarded as an aide to education, rather than to be seen as integral to the delivery of educational services." Much of the current literature advocates caution when proceeding with educational technology and points to a multitude of issues requiring consideration. First, and foremost, is the importance of planning. Locatis (1987) warns that planning is particularly crucial because instructional environments relying on technology can be complex. The Technology in Education Committee, Department of Alberta Education, has in fact adopted a definition of educational technology which "recognizes that the imperative of any technology is the planning component" (James et al., 1987).

iii. Courseware

The planning process must incorporate consideration of the quality of materials and programs (Niemi and Gooler, 1987). In his article on instructional design, Locatis (1987) makes the following observations on existing courseware:

Courseware development is a challenging process.

Most programs using new technologies fall into one of three categories: those that teach effectively but are dull, those that are imaginative but do not teach, and those that do not teach and that are not imaginative. There is, of course, a fourth category of programs that are both imaginative and effective. Commercially available programs fitting these categories are rare. Some innovative, largely experimental designs have emerged that involve learner manipulation of complex and varied information forms. But designing for new technologies is only beginning to be understood.

Courseware development, however, is a very costly and time-consuming process. In today's rapidly advancing information age, courseware, as well as hardware obsolescence must be taken into account. Other factors to be considered when undertaking instructional design are listed by Locatis (1987):

- **Instructional Context:** The targeted learners and their location during instruction must be identified.

- **Human Intermediaries and Technology:** Depending on the availability of subject specialists, technology may either dominate or support instruction.

- **Instructional Events:** Teaching fundamentals must be considered when devising instruction for new technologies. Otherwise, programs may not be fully effective.

- **Imaginative Use of Technology:** Technology can be used in innovative ways, particularly when different modes are used together. Old methods used with new media can obviate technology's potential.

- **Navigational Aids:** Information stored electronically is often not randomly accessible to the learner. A hard-copy book, for example, allows the learner to gain an overview of the information contained therein. The electronic environment should also allow the student access to different pages of a lesson and enable him to enter and exit the program at will.

iv. Training

Teachers and students must be trained in the use of technology.

Once appropriate hardware and courseware have been determined, the users of the technology must be trained. Interviewees suggested that teachers might be somewhat resistant to the use of technology-based instruction because they are not comfortable or familiar with it. Hudspeth and Brey (1986) recommend support and in-service training for faculty: "Without this broad support base, mediated instruction can easily be accused of being of less quality than instruction provided by traditional means." The students, too, must be prepared to use the technology to accomplish their learning objectives. As Niemi and Gooler (1987) indicate, the learner will not be able to take full advantage of the technology unless he or she is comfortable with it. All the key players, teachers, students and administrators, must understand how to access the new information resources.

v. Cost

As suggested by the discussion on courseware development, consideration of cost is a major factor in deciding which hardware and software systems to integrate into a distance education suite.

Cost determines software and hardware choices.

Initially, technological installations require major capital expenditures. Operating costs for electronic transmission of data are also substantial, and thus one must consider if the same ends can be achieved through less innovative, more traditional means. For example, relaying extensive documentation via a FAX machine is inordinately expensive compared to postal delivery in instances where time is not critical. If the aim is to reduce the costs which would be incurred by hiring teachers for remote areas, the long-term costs of different technology modes must enter into the determination of the appropriate mix of traditional and technology-based instructional delivery.

In *Visions 2000* (May 1987), the Technology in Education Committee summarizes the factors which are critical to an educational system employing technology:

Successful implementation will be based on an appropriate approach to technology, a thorough knowledge of learning, and an awareness that the teaching-learning process, the curriculum, technology, and the related political/financial/managerial *issues cannot be considered in isolation. Rather, these areas constitute a complex and dynamic ecology which must be considered as a whole if we are to plan effectively for the twenty-first century.*

The requirement for such an integrated approach is implied by Robertson (1987) writing specifically about audio teleconferencing. He cautions that this mode must not be considered by users “simply as a money-saving replacement for some of their current activities.” Instead, users must view teleconferencing as part of an integrated learning system, “designed to create effective interactions between the learner and what is to be learned. It provides teaching and learning strategies, materials, experiences, support and evaluation to promote learning” *(Visions 2000, 1987).* Similarly, writing about their experience designing a distance education system using teleconferencing and computer graphics, Winn et al. (1986) state that “the success of this, or any subsequent project relies not on sophisticated hardware but on the skills of designers, programmers, subject specialists and instructors.”

A number of critical factors must be considered when implementing technology-based instruction.

Thus, technology alone is not the answer. Even careful consideration of the foregoing critical factors might not ensure successful implementation of expensive high-tech learning systems. Watson, Calvert and Collins (1987) list potential problems which could limit the future of distant learning technologies: “equity of user access, societal acceptance of distant education, reconciliation of technological innovation, political and economic realities, and marketplace factors.” Despite this seemingly negative view, the persons interviewed during the course of this study, as well as the literature surveyed, confirmed that judicious use of appropriate technology is integral to distance education, both today and in the future.

2. TECHNOLOGY REVIEW

Overview

The technology explosion of the last ten years has brought with it expansive information serving possibilities. To grasp the present and future implications of this technology on distance education, one must understand the options. By necessity, this must include not only an overview of the current technology, but a look to the future. Advances in several fields have provided options for the distance educator. Perhaps the most dramatic area of advancement has been in the field of computers, especially microcomputers. Other areas, including telecommunications and television/video, have also experienced major changes.

Computers and telecommunications are rapidly advancing the ways in which information can be made available.

Basic Technology Components

A contemporary distance education suite would include components from the various technologies, and should be designed to provide a number of basic capabilities. First, there must be some form of hard copy transfer ability between the student and the instructor. Traditionally, this has been handled by the mail system, but current alternative methods include computer transfer, teletype, and FAX. Secondly, some form of interactive capability between both the instructor and other students is required. To date this has been done primarily through a telephone link. Current technology allows greater flexibility in the methods employed to achieve this interaction. Computer conferencing across existing data networks has become a common form of remote interaction. This type of conferencing requires that each individual taking part in the conference have access to a computer terminal. In some configurations, this can be linked with voice conferencing to provide both voice and data capability. This technology, although relatively young, has proven to be somewhat successful. With the advent of digital cabling (fiber optics), increased voice-over-data capability will be available. Fiber optic networks, however, are not going to be a reality in rural Alberta for at least 10 years.

The student and instructor must be able to transfer hard copy.

Another common method of interaction is phone conferencing (also referred to as teleconferencing). Phone conferences allow a number of persons over large distances to establish voice contact or, when used in conjunction with a video link, one-way video and two-way voice contact. Though this form of conference can be impersonal, it is easy to implement and requires little equipment. In the case of one-way video and two-way telephone conferencing, some form of video link is necessary. For $2000-$3000, a satellite receiver can be used to pick up the video signal allowing the instructor to be viewed as well as heard. However, uplink video equipment is expensive for the broadcast end. The most expensive method of achieving interaction is two-way video. This allows both audio and video connections to be established in both directions.

The student and instructor must, at some stage in the education process, be able to talk to each other..."real time" interaction.

A third necessity in distance learning is access to materials and information resources. This service is often the most difficult to provide in the remote location. Traditionally, the provision of educational resources has been through television or the mail system. Today, we can access information through a number of means. Direct computer access to online database services gives anyone with a telephone and a terminal access to virtually any type of information. CD

The student must have access to information. Computer access to databases, combined with new laser disc technologies provide vast new potential for all students.

ROM(CD- Compact Disk, ROM - Read Only Memory) technology provides vast storage capacity allowing computer access to large databases directly. Colliers Encyclopedia is currently available in the CD ROM format. This technology is very new but has great promise. Sony is rumoured to be coming out soon with titles in a format comparable to compact disks. Television has advanced so that not only are services provided over traditional channels, but specific educational needs can be addressed through the use of satellite or existing cable networks.

As we can see, the choices available to the distance educator for delivery of the three basic requirements, hard copy delivery, educational interaction and resource access are varied. It is, therefore, important to look more closely at the various options in each of the areas discussed.

Hard copy Delivery

The computer screen is not considered a viable substitute for written information. The challenge is to provide fast means of transfer at affordable rates.

Despite the electronic information explosion, hard copy is still a very important aspect of communication. It is very difficult for most people to edit or correct documents on a computer screen. One of the great drawbacks of the traditional mail delivery of documents in a correspondence/ distance education setting has been the delay in the feedback to the pupil on assignments. Much faster methods of hard copy transfer now exist, which can reduce this feedback time greatly.

- FAX

All that is required is a FAX machine and a dedicated telephone line.

FAX, or facsimile transfer, is currently a hot business market. The speed and quality of the latest generation of FAX equipment has made them a practical alternative to the mail system for hard copy transfer. In the distance education suite, FAX capability would allow for the bi-directional transfer of hard copy between the instructor and student at a relatively low cost. The equipment required includes a telephone line for each FAX and the FAX machine. FAX machines generally cost in the range of $2000.00 - $3000.00, but the price can be $10,000.00 or more for the latest generation of plain paper FAX machines. One of the major limits of FAX is the supply and line costs of transmitting large amounts of information. The average FAX is a thermal printing device, and thermal paper is expensive. This will change as plain paper FAX machines become available at more reasonable prices. Transmission time for a FAX is approximately one minute per page. For large usage, line charges can get expensive. In addition to these costs, the FAX could prove to be a bottleneck in a larger class/ distance learning facility.

At one minute per page for transmission, the line charges can get expensive, and there may be a bottleneck.

Most people are familiar with FAX as a stand-alone technology. Recent developments in the computer field allow for a FAX Modem to be hooked directly to the computer, which then acts like a FAX machine. A FAX modem is a device which takes normal computer output, which may include graphics as well as text, converts it to a format acceptable to receiving FAX machines, and then transmits this information. When receiving, the reverse process is performed. This allows the transfer of images between various computer systems as well as FAX machines. Integration of the FAX and computer has advantages and cost savings, because transmitting documents directly from the computer saves both effort and supplies.

A computer may be hooked into a FAX modem so that it will act like a FAX machine.

A FAX device for a computer costs in the range of $1100.00. In addition to the initial cost savings, supply costs are lower because a computer is generally connected to a plain pa-

Savings if a computer is used for FAX transmissions.

per printer. If the computer is to be used for FAX transmission, then access to a telephone line must be provided. One of the major drawbacks of a direct FAX computer connection is that the computer must either be dedicated to FAX access, or be equipped with software allowing the FAX to operate in the background. The connection in the background can have a major effect on the operational speed of the computer.

- Computer Transfer

Text, graphic information, computer programs and data files can be moved from one computer to another.

In many ways, computer document transfer is similar to FAX transfer, the major difference being that a greater variety of information can be transferred. Not only can text and graphic information be sent, but computer programs and data files can be moved from one machine to another. This type of link requires a computer equipped with a modem on each end. Modems vary considerably, but the standard speed for most communications is 1200 baud. Modems over existing telephone connections can achieve rates of up to 9600 baud, and with data compression techniques, through-put can come close to 19.2K baud.

Network users can communicate with each other through bulletin boards and mail boxes.

For the computers to link, there must be some form of compatibility on each end of the connection. This can take the form of a mini computer, allowing files to be downloaded and then retrieved later by an instructor, or of a similar machine set up as a bulletin board type system in which documents could be left. Bulletin boards can also operate on microcomputers with floppy disks, but it is advisable to use a hard drive. It is possible to provide a mail box through use of non-intelligent devices such as the Hayes Transet 1000. The Transet is basically a buffer, or block of memory, with a small amount of internal software that allows one to access this memory and leave information in it for later retrieval. Several of these Transets hooked through a multiplexer can provide multiple port dial-up access for students calling in from the remote stations. Files could then be left for later pick-up by the instructor.

If the remote learning centre contains a networked computer lab, access to the dial-up system should be made available as a node or address on the network. This gives all the users access to the modem and thus to the dial-in facility. Via network access, the possibilities of interactive network linking become a reality. Two or more working groups in separate locations could link together across network bridges and function as a contiguous unit, exchanging files and information transparently. The latest generation of computers have sufficient speed and power to be effective in such an environment.

- E-Mail

A computer or a terminal is required for E-Mail access. Large document transfer requires an intelligent terminal for documentation preparation and storage.

E-Mail, or Electronic Mail, access requires the use of either a computer or a computer terminal. Several E-Mail alternatives are available on a commercial basis. The most commonly used in Canada is the Envoy system. Using E-Mail reduces the cost of the equipment required to transfer information back and forth between users. One of the major limitations of E-Mail is that in order to transfer large documents, the user must have access to an intelligent terminal or computer for document preparation and storage. The type of information stored on the E-mail system is generally text in nature.

Teleconferencing

The ability of the instructor to interact with the pupil on a real-time basis has previously been ignored in distance education. With correspondence courses, interaction was limit-

A major disadvantage of teleconferencing is associated with scheduling problems. Students in different schools must be available at the same time.

ed to the weekly mailing of assignments and possibly some phone contact. The possibilities for interaction have greatly increased, and much focus should be placed on the ability of the instructor to interact immediately with the student. However, one major difficulty related to real-time contact through teleconferencing is scheduling, because all students must be at a particular place at a specified time.

- Computer Interaction

Similar in some ways to the delivery of hard copy via computer, the computer allows for the various individuals involved in the learning situation to set up computer conferences. Perhaps the easiest method of doing this is through the use of modems on each computer to dial in to a central service where the ability to chat between connected users is available. Several services of this sort exist, such as the Source, Compuserve, I-Net, etc. Computer conferences, though somewhat impersonal, do allow users separated by great distances to communicate effectively. One of the major drawbacks of computer conference is that it is somewhat dependent on the ability of the various users to type and interact with a computer. For people unfamiliar with this technology, this can prove to be an intimidating experience. Currently, this type of conference is primarily limited to data transfer. There has been some advancement in the area of voice-over data communications allowing a simultaneous voice-over data transmission. The major disadvantage to current voice-over data technology is the relatively poor quality of the voice portion of the transmission. With the advent of fiber optic networks, voice and data communications will become more feasible.

Several central services allow connected users to communicate with each other through a computer conference.

Computer interaction is currently limited to data transfer.

In addition to public access to computer networks, it is possible through a number of other means to provide interaction via the computer. One that is currently on the leading edge of communications technology is network bridging. As mentioned in the section on hard copy delivery, the ability to transfer files and other information when linked together over a network bridge is a reality. There are also a number of simulations which can be run by a number of people on the network and function simultaneously with full interaction. The possibilities for multi-participant simulation learning situations are facilitated by the current network bridging technology. Secondly, it is possible to hook teleboards or telewriters (devices similar to a digitizing tablet or touch sensitive screen) to a number of machines and have them hooked to a more powerful central machine enabling transmission of freehand written information between the various participants. Though this method can prove to be effective in achieving real-time blackboard-like interaction, many of the later generation computers have this type of capability with little additional hardware required.

Information can be transferred between users connected by a network bridge. This technology facilitates simulation learning.

- One-Way Video/Two-Way Audio

In a classroom setting, this can prove to be a valuable learning tool. The video image coming from at least one direction provides a sense of familiarity to the student. The equipment necessary to implement this form of interaction would consist of phone lines to the various stations and a main satellite dish allowing the site to pick up the signal. Cost for a receiving satellite dish would be approximately $2000.00 - $3000.00. This form of remote interaction requires little technical expertise at the remote site. The ability to tune the dish from one satellite to another

A video image of the instructor gives the student a sense of familiarity.

and the ability to set up the telephone conference call are the major requirements at the remote site. Most of the technical capability is required at the transmission end of the line.

- Two-Way Audio/Video

Two-way video can provide the instructor with a visual of the students. However, monitoring of students can be better achieved through an aide on-site.

Another option for remote interaction is two-way audio and video. To implement this type of technology requires that both the remote site, as well as the central serving location, be equipped with satellite receiving and transmission equipment. This can prove to be expensive; but the cost can be somewhat justified through the reduction in line costs associated with one-way video, two-way audio transmission, as the satellite link can handle both audio and video signals. In addition to the high cost, it seems that, aside from having a visual of the person with whom one is connected, very little purpose is served by the two-way video link. If the purpose is to monitor the class, more effective control can be achieved through the use of an aide in the learning facility.

- Two-Way Audio

Learning through discussion can be accommodated by two-way audio communication.

The least technologically advanced method of interacting is two-way audio communication. In this scenario, a phone link between the various sites is established and all communications are on an audio basis. This can prove effective for discussion-type learning situations, but it does not address the lecture option. With a strictly audio connection, the student is likely to lose interest and be less attentive to the learning process. One of the other major disadvantages to this type of interaction is the inability to convey visual information. Any hard copy or visual stimulation must be supplied by another means in advance of the conference. This approach calls for substantial planning and prior notice of the conference and discourages impromptu contact and interaction.

Resource Access and Information Serving

Information must be meaningful and accessible.

The greatest challenge to the distance education facility is making the information being taught meaningful and accessible. Information must be available to both instructor and students as required. As has been noted, a number of technologies can serve the requirements for hard copy delivery and interaction capability. Most of these technologies also have a place in the provision of information over and above that provided by instructor/student interaction.

- Computers

Hardware

Various technologies can be integrated by the computer.

Computer technology provides perhaps the greatest opportunity for distance education. The advancements in the area of microcomputers have allowed information to be provided though a variety of mediums. The continuing integration of the various other technologies through the use of the computer makes this component essential in any facility.

Existing installations include computers, disk drives, a video display and access to a printer.

In the province of Alberta the majority of the installed computer base is Apple II's and //e's. This must be kept in mind when examining the possibilities available to the distance education facility. Hardware is one of the major costs associated with the computer as a learning tool. The existing installed base consists mainly of Apple //e computers with either single or double disks drives, a video display, and access to a printer. In most cases these machines are stand alone, but there are a number of Corvus networks where the machines share peripherals as well as a common hard disk, whereby the Corvus disk drive is a file server which has its own built in intelligence. Each user is then given space on the drive, via the network.

This configuration is conducive to both individual study situations and computer lab arrangements. There are, however, several limitations on the individual station as an alternative. These are discussed as follows:

When used simultaneously by a number of people, software must be available on disk or loaded into each computer's memory.

Each individual station must be equipped with its own set of software. Software when used simultaneously by a number of people must be available on its own disk or be loaded into memory on each machine in order to operate. If the second option is taken, someone must load the software onto each machine before the machines are used. This is time-consuming and may lead to problems during a session, should the software need reloading.

Sharing of resources requires monitoring and consistency.

Printing in this environment creates a bottleneck. Several options can minimize this problem. Each machine can be equipped with a printer providing constant access. With the least expensive printers costing $400.00 - $500.00, this can prove costly. If the lab is designed so that the machines are close together, the sharing of a single printer between multiple stations can prove to be effective. The print volume determines the number of stations that will use each printer. Some form of manual switch box which allows each machine access to the printer will be necessary. Any sharing of resources requires monitoring. Ground rules will need to be developed for sharing of the printer resources. The least effective method of providing printing facilities is through the use of dedicated printer stations. This situation requires that each person load his/her software onto the machine before printing the document. This process is slow and cumbersome. Where different computer configurations exist, printing may be impossible due to the incompatibilities. Consistency, when several people are sharing the same machine, is extremely important.

Access to the outside world requires costly online connection. A multiplexer can reduce the cost.

If the station is to communicate directly with the outside world, a modem (devices which take the signal generated by the computer and modify it to a form acceptable for transmission over telephone lines) is required. The same configurations outlined for printers apply to the use of modems. If much of the teaching is to be done through a remote system requiring a constant online connection, consideration of the line costs involved is necessary. A multiplexer can reduce line costs through multiple access to a high-speed modem and single phone line. In most cases, access to the outside world will be more limited; access will be confined to online data services and computers used for up and downloading files and reports. In this case, access can be acceptably provided through one or two machines.

When considering the layout of the individual station, we can see that the configurations would be very similar. The cabling for these stations requires adequate power supply, with at least four plugs, probably provided through a power bar. The only other access required would be to the common printer and to an outside line as required.

Individual stations in a network have a computer, a monitor and a disk drive.

The implementation of some form of network, allowing the various machines to be linked together and share resources, is a more current technological option. Though other options are available, the Corvus network is one of the most commonly used networks in the Apple //e environment. A network consists of individual stations having a computer, a monitor and preferably one disk drive. Implementation of a network can be cost effective. The initial costs per station can be reduced through use of shared resources. Generally, printers and modems can be set up for common access. Savings can also be made on supplies and maintenance costs over the term of the installation.

Lab layout must be planned before computers are installed.

Cabling for a network requires consideration of the layout of the lab or facility before installation of the computers. As each machine is linked in sequence, allowance for the required cabling is necessary. It is important that the cabling be accessible and redefinable in order to facilitate changes in the layout at a later date. Location of tables along a wall with a cable conduit along the base of the walls and along the tables to provide cable access is preferable. In some network implementations, existing phone wiring can be used. This should be considered, if the option is available, before phones are installed. It may be advisable to install extra phone jacks to provide network access. If teleconferencing is to be used, the network and phone access can use the same cabling system. If possible, wiring should serve dual functions.

Cables must be accessible and moveable.

Wiring should serve dual functions when possible.

A computer network requires a central control station.

When a computer network is to be used, a central control station is necessary. This station is generally fully equipped. In the case of an Apple //e configuration, this would include the basic configuration, as above, with two drives, possibly extra memory, and a hard drive. This system would be the supervisor's and would handle the administrative tasks necessary to maintain the network. It is important when implementing a network configuration to consider the additional expertise required for ongoing operation and maintenance. One individual, referred to as the network manager, is responsible for insuring that the network is kept functional. This entails monitoring of the resources available over the network, allocating space on the shared storage devices for user access, and implementing regular backup procedures to insure data is not lost.

A network manager must be appointed. The degree of skill required to monitor networks may pose a problem in remote areas.

Both individual stations and networks require software maintenance and management on an ongoing basis. Networks require a much greater degree of skill in order to function effectively. In a remote situation, this requirement may pose a problem, because technical expertise will not be readily available. As a general rule the more technologies that are employed, the greater the expertise required by the system manager to maintain the system.

The Apple //e has been around for a number of years and as such is not comparable with current technology. If new machines are to be purchased, then more current equipment is in order. The optimum configuration would contain 1 megabyte of memory or more, 1 diskette drive with minimum 700k- 1000k storage, a high resolution screen, hard disk access, CD-ROM access, video interface, audio interface and FAX modem capability. Access to a network, a network bridge, a modem and a printer should also be provided. Such a station would cost in the range of $15,000.00. Although this cost is too high to allow for multiple stations, the various technologies do warrant future consideration.

The optimum configuration for a workstation would cost about $15,000.00.

Over the past few years, we have seen the development of the graphic interface for the computer. This technology originated at the Xerox PARC facility and was adopted by

Graphics capability requires increased micro computer memory.

Apple for its Macintosh. Recently, the graphic interface has become available on the PS/2 by IBM in the form of Microsoft Windows. In order to support the software overhead necessary for the operation of a graphic interface, the memory of the current generation of computers is in the order of 512k to 1 megabyte. The requirement for disk storage is also increased by the handling of graphic information. As the use of graphics increases, there will be continued pressure for increased memories in micro computers. Though this entails cost, the use of graphics to provide the interface between the user and the computer has proven to be effective in reducing learning times and in lessening the level of expertise required to operate the machines. If the computer is to be used with a younger audience, this ease of use may prove invaluable.

CD ROM gives all users of a network access to large databases of information.

The processors in the current generation of desktop computers are much more powerful than those in PC's and Apple //e's and allow for the implementation of a wider variety of services within the computer environment. The advent of CD ROM may be one of the more significant advances in the area of computers for the distance learner. Although this technology is very new, it has been adopted by several businesses to convey large volumes of static information to the end user. With a storage capacity in excess of 600 Megabytes, the volumes of information available locally on-line have increased several hundred-fold. A CD ROM disk on a network gives all users of the network access to large databases of information. Presently this is a “read only” technology, but the future should yield a “read write” product with similar types of storage capacity.

Software

Software should precede hardware choice.

Up to this point, the computer has been discussed from a hardware perspective. In any computer installation, the synergy between the hardware and software components of the system provides functionality. When looking at the viability of a particular system, it is important to look at the software options available. Hardware is the easy part. Finding readily accessible software to fit a particular requirement is often difficult. In many cases, a thorough review of the software is the first step in choosing a computer. Once the availability of software is determined, the choice of hardware becomes evident.

- *Hypertext*

Hypertext allows for retrieval of varieties of information within a single software environment.

Hypertext is the newest of the software technologies to be introduced. One of the more visible forms of hypertext software is the Apple Macintosh program called Hypercard. The concept of hypertext is that a large pool of information can be arranged through a variety of relationships. These relationships allow data of dissimilar types to be related and combined in an unlimited number of combinations. The relationships are built by the user and reflect the user's information handling bias. The major advantage within a hypertext software application is that varieties of information, including graphics, text, databases and applications, may be set up for retrieval in a single software environment. The information does not have to be similar in any fashion. The only requirement is that the user define a relationship between the two pieces of information. Where links have not yet been defined, it is possible to search for information globally without having predefined any key words or relationships.

For example, a piece of hypertext relating to Edmonton might allow for access from within an article about Edmonton to information on demographics, physical location, maps, history or a number of other information categories. This, in turn, could relate to information pertaining to other cities of similar size or age, etc. Hypertext allows for the handling of large volumes of information, such as can be made available by the CD ROM technology, in an intuitive fashion. The links are soft defined and the flow is entirely in the hands of the user. The major problem with the hypertext software concept is that when the data is taken from one user to another, the relationships defined by the initial user may not follow the thinking patterns of the new user. This can result in jumbled access arrangements and lack of flow within the information pool.

A disadvantage of Hypertext is that different users must follow similar thought patterns.

- *Simulations*

Simulations allow the user to participate in the decision making processes required to deal with a real life situation. The nature of this form of knowledge dissemination makes the learning process game-like in nature. With current technology, simulations may be either single user, as in a stand-alone workstation environment, or multi-user. For the simulations to function in a multi-user interactive mode the users must be connected either through a network or a remote dial-in to a central computer running the simulation. One of the great advantages of simulation is that it provides the learner with a realistic learning situation. This software technology is ever advancing, and as networks of computers become more widespread, the potential for simulation learning programs becomes greater.

Simulation provides a learning experience via an imitative device or process.

- *Drill and practice*

Since its introduction to the field of education the computer has primarily been used as a drill and practice device. Large amounts of software pertinent to most disciplines are available for drill and practice requirements in the distance education situation. While there is certainly a need for some drill and practice instruction, it should not be the major focus of the computer as a learning tool. The computer's potential is barely utilized in this situation.

Drill and practice does not fully utilize the computer's potential.

- *Information Access*

Several means of information access are possible through the computer. As discussed in relation to hard copy delivery, written information can be transferred to and from the computer via modem. This information can be provided directly by the instructor or by a central computer set up to service the distance education centre. In addition to dedicated services, a number of online information utilities can provide access, via modem, to bibliographic databases, news services, business information databases, etc. A full view of the types of available information is provided by AGT's catalogue of services available through I-NET. The I-NET service provides access to most of the available services through one sign-on number. Many of these database providers offer full text of major publications which can be downloaded to the computer. These types of information services give the remote learner access to as much, or perhaps even more, information than would be accessible to a learner in an urban environment without the use of a computer.

Information services give the remote learner as much, if not more, access to data as is provided to the urban student.

The major drawback to the online services is the associated costs. Services access costs range from $20.00 to $50.00 per hour of connect time, with line charges additional. Most major centres have Datapac network gateways so the line charges would only be to the major centre. If high usage is envisioned, this type of information access can become very expensive.

Online services can be very expensive.

Currently, CD ROM disks cannot be erased and reused.

Information can also be served through CD ROM technology. CD ROM and CD WORM (WORM - Write once read many times) equipment uses laser technology to store information in a form similar to that on compact disks. When used for computer generated information, the disks can store amounts of information greater than 400 megabytes per side. The disks themselves are very reliable and have an expected life of at least 10 years. The major disadvantage to this medium is that disks cannot be erased and reused. This will probably change over the next five years, although commercial availability is still further down the line. With the expected growth in this area, several database options will be available to cover a variety of information needs. The cost of providing information in this format is limited to the cost of the database and of the CD ROM device. A CD ROM player is expected to cost in the range of $2000.00. Currently, the cost of databases on the CD ROM are high, greater than $1000.00 per database; but with economies of scale, this cost should decrease markedly in future. This type of information database should work effectively with the Hypertext software technology.

CD ROM database costs are currently high.

The final method of information serving via the computer is through the linking of various networks. Through this connection, the users on any of the various networks are able to exchange information among themselves. This method of transferring information among separated users is the most interactive. In all cases, hardware additions will likely be required to allow access to the various types of available information.

- *Monitoring Software*

Monitoring software allowing the instructor to track the progress of any student is a necessary adjunct to a computer used in a learning situation. Presently, this area of software is the least developed. In some courseware, the monitoring facility is built into the software. In the network environment, software is generally available to monitor the usage of the various network devices. Networks also can allow review of student documents by the network administrator. The integration of these two monitoring processes is what is most in demand. Given the current installed base and the state of existing software technology, a fully integrated monitoring system is still several years away.

Software allowing the instructor to track the student's progress and review student documents will be most effective when integrated.

If the monitoring of the students in the distance education facility is to be effective, development of the monitoring system would likely have to be undertaken in-house. The lead time for this type of project would be in the order of 1 to 2 years.

- Video

Videotape

Presently, several methods deliver visual information. Perhaps the most widely recognized is the videotape. This is generally a stand-alone technology, although it is possible to integrate video tape with the computer. The sequential access nature of the video tape can limit its effectiveness. The major advantage of videotape is its ready availability and the relatively low production costs. Also important is the record/playback capability of the video tape recorder.

Effectiveness of video tape is limited by sequential access.

HDTV

Presently, video is beginning to embark on new frontiers with the advent of HDTV(High Definition Television). The improved quality of the images bodes well for this technology in the future. Currently, there are no commercial HDTV facilities, but Canada has recently begun programming in this format and, as such, is the world leader. It will probably be 5 to 10 years before HDTV is readily available.

Videodisc

Videodisc allows for random access to information.

Little videodisc courseware currently exists.

Videodisc video technology provides great promise for the educator. Although this technology has been around for a number of years, it has been overshadowed by the videotape as a means of distributing video information. As with compact disk, the inability to record on or erase the disks for reuse has limited its popularity as a video medium. This tends to make production and replication of video information more expensive than videotape and explains the relatively slow consumer acceptance. The major advantages of the video disc are the random access nature of the medium, the capability to interact with the video via a computer, the improved quality of still images and the long life of the actual media. A videodisc can handle approximately 1.5 hrs. of video information. Videodisc courseware is available in limited quantity, but if this technology is to be used extensively, then considerable development time will be necessary.

CD ROM

CD ROM is presently able to handle graphic, video, audio and computer generated information.

CD ROM and CD/I are technologies very similar in form to videodisc. The compact disk used for audio information is comparable to the CD ROM format. The acceptance of compact disks has led to greater acceptance of all laser disc technologies. CD ROM appears to be the beginning of the standard medium. It presently has the ability to handle graphic, video, audio and computer generated information. Though the current capacity makes it somewhat limited for video information other than still shots, the future is promising. Once again, as with the videodisc, the great advantage of the CD technology is its ability to integrate several types of technology. **Within ten years the capacity to handle all forms of information through one medium will have major impacts on serving information in all its forms.** This is one of the most exciting developments of the last few years.

A key component in all the above processes is the communication connection.

Communication Options

- Teleconferencing

Telephone conferences require a conference facilitator if there are a number of participants.

The most basic long distance communication connection is the telephone, which is by far the most common method of implementing a communication link. Most of us are familiar with standard voice communication in its most basic form, that of the two-party conversation. This is only one of the methods of communication which can be established through a telephone link. Via many in-office or school phone systems, it is possible to establish conference calls among multiple participants. Through arrangement with the phone company, a variety of participants in a number of distant locations can partake of a similar phone conference. One of the major drawbacks of this form of communication is that where there are a number of participants, control over the interaction requires a conference facilitator. Secondly, the lack of video contact removes the visual portion of the contact and thus the associated cues which normally aid verbal interaction. The greatest advantage to this form of conversation is the small amount of equipment required and the ready access to this form of communication.

- Telephone Lines

Phone lines are also used in many forms of computer communication. Access to on-line database service is normally gained through a phone

Telephone links can provide access to a number of communication devices, including one-way video, computer conferencing and FAX.

call via modem to an access port. This access port may then switch to an alternate form of transmission to continue the communication link through to the second parties. Datapac, a Canadian packet switching network, is accessed in this way and has dial-up ports at speeds of 1200 to 2400 baud in most major centres. Through the use of a modem, it is possible to establish a computer connection between almost any two microcomputers or minicomputers, although there are exceptions to this rule in the IBM mini and mainframe environment. To communicate directly with these computers may require a device known as a protocol converter. It is also possible to purchase access to a direct line between two sources from the telephone company. These lines allow for continuous connection between two sites. The line is generally less likely to experience interference. This form of phone link is expensive; but in a remote area where the access via computer will be fairly constant, the costs may be less than long-distance charges. This form of link requires more modems which are more costly than those available for the dial-up environment. FAX is also a phone link and functions very similarly to a modem.

Phone links, as outlined, can provide access to a number of communications devices. The phone can also be an excellent complementary communications link. When used with a one-way video connection from the instructor to the student, it allows for a more intimate communication with the students and gives interactive capacity to the broadcast image/audio. This is one of the more common forms of teleconferencing and is relatively inexpensive to implement, requiring only access to phone lines and a television, although additional equipment is required to provide the video. Phone links can also prove complementary to computer conferencing and even to FAX delivery, though in a much more limited fashion than with video technology.

- Satellite Communications

Satellite communications links have become familiar to most people through their use of television receivers. This is by far their most common form and it can provide an excellent communications link for distance education. The implementation as a one-way transmission device allows for the transmission of video, audio and computer signals to a receiving dish. The technology required to receive the signal is relatively inexpensive...between $2000.00 - $4000.00 for a receiving dish. Programing may be forwarded immediately for transmission. Satellite transmission capability is offered commercially by a number of companies. If transmission facilities are required, then the cost of the implementation is relatively high. This is also true for two-way satellite transmission. Production facilities and transmission equipment require additional staff with a technical background to manage the equipment. This expertise may not be available in many remote locations. In most cases, one-way satellite transmission is probably sufficient.

Satellites transmit video, audio and computer signals to a receiving dish.

Transmission facilities and two-way satellite transmission are expensive.

- Microwave Transmission

Microwave transmission is a third communications option, which is generally used for business and industrial communication. This form of link is generally line of sight and has a limited range compared to satellite. Given the requirements of the distance educator, this form of communication is not applicable.

- Cable Television

Cable television service is provided in may centres. Though not available

Presently, cable service provides one-way communication.

in many remote centres, it can provide an alternative to satellite where accessible. Not only is cable access likely to be less expensive than a satellite connection, the cable companies usually have production facilities available, thus incurring further cost advantages. Cable service is a one-way communication, although advances may at some point lead to interactive cable. As such, some other form of communication is required to provide interactive capability.

- Fiber Optic Networks

Delivery of fiber optic service to remote areas may be a reality in a decade.

Fiber optic networks provide an excellent communications medium. When this technology becomes widely available, which is likely by the late 1990's, the communications options for the distance educator will mushroom. Though a fiber optic link is available between Edmonton and Calgary, delivery of this service to remote areas is probably as much as a decade away. With fiber optics, the ability to transmit video and audio information, as well as digital information, becomes a reality. The speed at which the fiber optic link can transmit digital data is 56k baud, which is roughly three times faster than the highest throughput available with conventional modems using existing telephone equipment. Modems required to function with fiber optic networks are much less expensive than modems for conventional operation.

Conclusion

Planning must precede installation of technology modes to optimize utilization of the equipment.

As has been outlined, numerous technologies assist in the delivery of distance education services. When assessing these technologies, one must keep them in perspective. Technology is a tool (not a means) and like any other tool preforms a specific function and requires a specific expertise. To perform a task, it is often necessary to use a number of tools. So it is with technology, therefore, that a number of options must be provided in the distance education suite. In order to gain optimum utilization from the equipment provided, considerable thought must go into the integration of these forms of technology prior to installation. Too often, technology is acquired with no definite plan for its usage and is an end in itself. It is also important to evaluate existing forms of communication, such as mail, and look at their continued application for delivery of distance education services. Too often perfectly effective systems for handling information are traded for new technology which has functioned much less effectively.

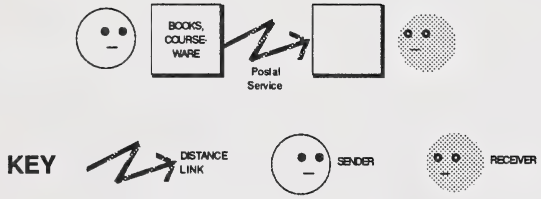
The expanding options which will face the distance educator during the next ten years are exciting. Access will be available to major library and information resources around the world, and the ability to interact with other students in distant locations will be a reality. Much work will be required to develop the integrated approach to technology; but the end result will probably be worth the cost, because the distant student will have access to quality instruction through a variety of mediums. The tools are here; all that is required is the ongoing effort to optimize their utilization.

3. DISTANCE EDUCATION MODES

The following pages are designed to familiarize the reader with important factors about the different modes of distance education. A schematic layout is included to explain the basic configuration that is required to enable each mode to function. Also, the principle characteristics for each mode are listed. Accessing these modes, therefore, means that the advantages, disadvantages, cost considerations, etc. must be weighed with the instructional suitability for particular subjects, before any fundamental choice(s) can be made for the types of workstations that will best serve students in a specific situation.

TECHNOLOGY MODE:

PRINT MATERIAL



ADVANTAGES:

- Extensive availability of courseware.
- Can be accessed anywhere, at any time.
- User-friendly.
- Can be reviewed at will in any sequence.

DISADVANTAGES:

- Generally long feedback cycle.
- Student must be able to learn independently.
- Student must have competent level of literacy.

EQUIPMENT:

INSTRUCTIONAL SUITABILITY:

- Facilitates acquisition of knowledge and understanding of abstractions.

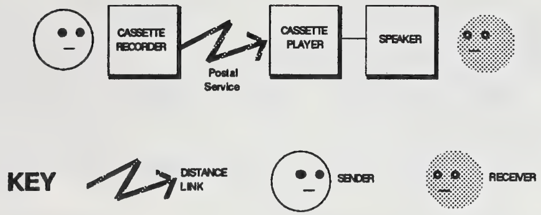
COST CONSIDERATIONS:

- Cost-effective mode, particularly if delivered via postal service.

COMMENTS/ CONCERNS:

Print material is regarded as necessary by many educators, regardless of the technological modes available.

TECHNOLOGY MODE:
AUDIOCASSETTES



EQUIPMENT:

- Cassette player
- Audiotapes

COST CONSIDERATIONS:

- Cassettes and players are inexpensive.
- Production of course materials is relatively inexpensive.

ADVANTAGES:

- Material can be prepared quickly.
- Much audiocassette material already exists.
- Portable: learner can access at almost any time or place.
- Communication can be personalized.
- Integrates easily with other media.

DISADVANTAGES:

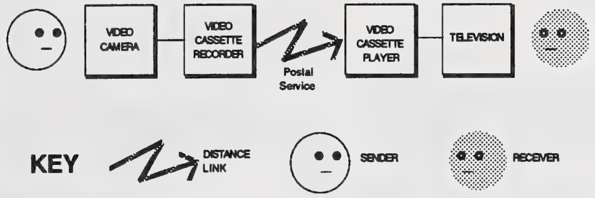
- May require reliance on postal service if used for communication between student and instructor.

INSTRUCTIONAL SUITABILITY:

- Suitable for aural learning.
- Particularly suitable for language, literature, drama, and music instruction.
- Students can control pace of learning by replaying cassette.
- Good complement to written or visual material.

COMMENTS/ CONCERNS:

TECHNOLOGY MODE:
VIDEOCASSETTES



EQUIPMENT:

- TV set
- Videocassette recorder (VCR)
- Remote control

COST CONSIDERATIONS:

- Production costs high.
- Low cost of medium.

ADVANTAGES:

- Flexible: learner can choose time for viewing program.
- Can be integrated with other forms of instruction or media.
- Read/write capability.
- Readily available.
- Familiar to most individuals.
- Long recording time (4-6 hours).

DISADVANTAGES:

- May require reliance on postal service for distribution.
- Courses suitable for this type of instruction are limited.
- Sequential access.
- Poor handling of still images.
- Image degrades with use.
- Does not integrate well with computer.

INSTRUCTIONAL SUITABILITY:

- Student can control pace of learning by pausing or re-playing the tape.
- Appropriate for visual learning.
- Good for transmitting knowledge; not suitable for achieving higher-level cognitive skills.
- Does not provide individualized feedback to students.

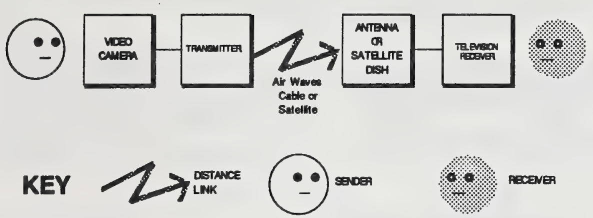
COMMENTS/ CONCERNS:

- Already extensively used for instruction (ACCESS).
- Most schools in Alberta have at least one VCR.

TECHNOLOGY MODE:

TELEVISION

(There are several modes of TV delivery: cable, satellite, off-air).



EQUIPMENT:

- Television set
- Dish for satellite reception.
- Can be interfaced with other modes (e.g. VCR, computer, camera, microphone).

COST CONSIDERATIONS:

Development costs are very high, but delivery costs are low.

ADVANTAGES:

- Student has ready access to television set.
- Cable:
  - large established network of subscribers
  - relatively low cost for use
  - production facilities available through cable company
- Satellite:
  - able to serve very remote areas
  - if access is bi-directional, one connection can handle audio, video and data transmission
  - excellent for teleconferencing.
- Off-air:
  - large transmission area, relative to cable
  - production facilities available.

DISADVANTAGES:

- Not flexible with regard to broadcast times. Commercial facilities often assign undesirable times to educational broadcasts.
- Technical expertise required for program production.
- Cable:
  - available only in larger centres
  - access must be arranged with owner
  - long lead times for program scheduling.
- Satellite:
  - requires satellite receiving dish
  - requires transmitting facility if transmitting independently
  - long lead time to arrange programming
  - if two-way communication, transmitting equipment required on both ends.
- Off-air:
  - tends to be commercially oriented
  - long lead times to arrange programming
  - expensive
  - cannot limit viewing audience.

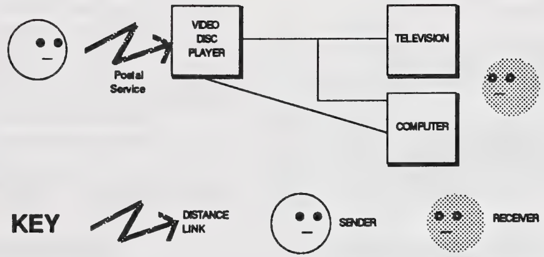
INSTRUCTIONAL SUITABILITY:

- Faciliates acquisition of knowledge and understanding of abstractions.

COMMENTS/ CONCERNS:

It is expected that videocassettes and interactive videodisc programs will be used more than television broadcasts for educational purposes.

TECHNOLOGY MODE:
VIDEODISCS



EQUIPMENT:

- Videodisc player
- Computer (optional)
- Software (optional)
- Monitor or TV set

COST CONSIDERATIONS:

- Very costly to have courseware developed.

ADVANTAGES:

- Interactivity between student and instructional material.
- Handles still images well.
- Works well with computers.
- Extremely reliable medium.
- No degradation of image with use.
- Low cost of final product.

DISADVANTAGES:

- Currently, most videodisc machines only have playback capabilities.
- Limited availability of software.
- Not highly accepted technology.
- High production costs.
- Playing time short compared to video tape.
- Not portable; learner must access equipment at central location.
- May require reliance on postal service for distribution of videodiscs and floppy discs.

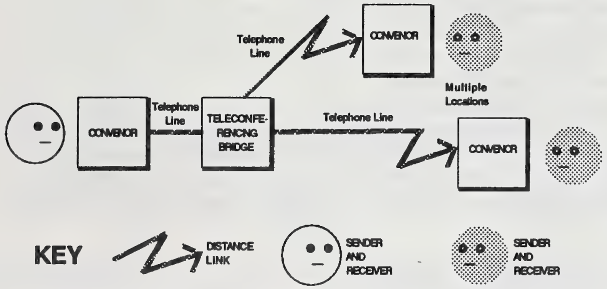
INSTRUCTIONAL SUITABILITY:

- Does not provide individualized instructor feedback to student. However, appropriate software can provide feedback.
- Student can control pace of learning.
- Material can be presented in print, visual images and sound; appeals to a variety of learning styles.
- Learner may access material randomly.
- Particularly suitable for transmitting knowledge.

COMMENTS/ CONCERNS:

- Expertise and access to equipment required to produce good videodiscs.

TECHNOLOGY MODE:
AUDIO TELECONFERENCING



EQUIPMENT:

- Telephone equipment and lines.
- Teleconferencing bridge.
- Convenors (microphone/speakers).
- Usually used with enhancements: print, videotex, television, telewriter, etc.

COST CONSIDERATIONS:

- High costs associated with long distance charges.

ADVANTAGES:

- Immediate interaction between instructor and students and among students.
- Lead time not much longer than for traditional classroom instruction.
- Equipment readily available.

DISADVANTAGES:

- No visual contact between students and instructor.
- Interaction modified by technological protocol.
- Learning must occur at a specified time and place.

INSTRUCTIONAL SUITABILITY:

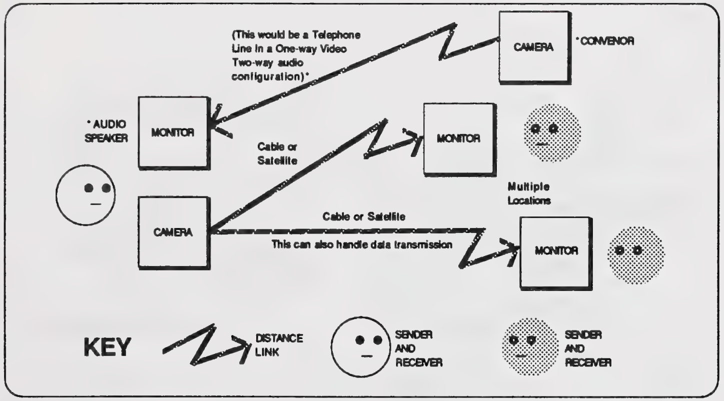
- Immediate feedback to student from instructor and other students. Provides motivation.
- Instruction more individualized because of contact with instructor.
- Accommodates aural learning style.
- Facilitates knowledge acquisition and understanding.

COMMENTS/ CONCERNS:

- Audio teleconferencing is well-suited to distance education because Canada has a very good telephone communications infrastructure.
- "Alberta is a major user of teleconferencing for delivery of post-secondary courses" (James et al., 1987).

TECHNOLOGY MODE:

VIDEO TELECONFERENCING



EQUIPMENT:

- Camera(s)
- TV monitors
- Telephone equipment and lines
- Satellite dish

COST CONSIDERATIONS:

- Cost for a receiving satellite dish is $2,000.00 - $3,000.00.
- High costs associated with long-distance line charges.
- Equipment purchase, rather than rental, is expensive.

ADVANTAGES:

- Students have visual contact with instructor.
- Immediate interaction between instructor and students and among students.

DISADVANTAGES:

- Interaction modified by technical protocol.
- Learning must occur at specified time and place.
- Technical expertise required to operate equipment: instructors require training.
- Instructor may not be effective on-screen, because students are accustomed to viewing professional actors through this medium.

INSTRUCTIONAL SUITABILITY:

- Immediate feedback to student from instructor and other students. Provides motivation.
- Instruction more individualized because of contact with instructor.
- Accommodates aural and visual learning styles.
- Facilitates knowledge acquisition and understanding.

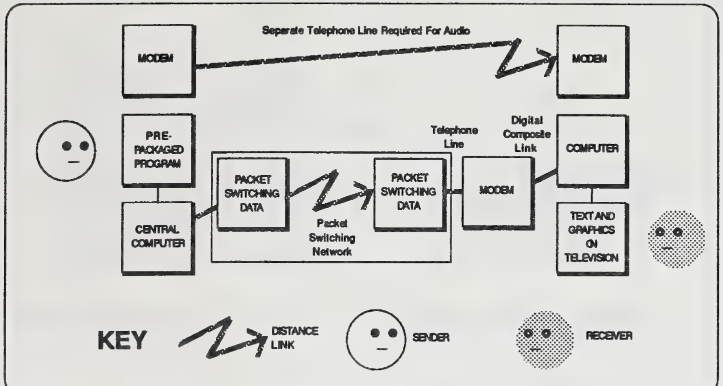
COMMENTS/ CONCERNS:

- Video teleconferencing is not used extensively in Canada because of its very high cost. The USA, however, has long had a network in place which allows for much more cost-effective access to video conferencing.
- Can be one-way video/ two-way audio or two-way video/audio.

TECHNOLOGY MODE:

VIDEOTEX (Videodata or Telidon)

(Terminology varies: The following information also refers to videotext, which encompasses viewdata and teletext.)



EQUIPMENT:

- Centralized computer
- Videotex terminals (keyboard & monitor)
- Telephone line or cable or VSAT (Very Small Aperture System).
- Packet Switching Network
- Modems

COST CONSIDERATIONS:

- High costs associated with creating Videotex database. "In Alberta implementations, Telidon enhancement to teleconferencing has been found to be too expensive at the University of Calgary. A Telidon delivered course developed by the Alberta Correspondence School cost 2-6 times as much to produce as a regular ACS course." (Organizing Distance Education Alternatives, November 1986, p. 194)
- Terminals, usuallyl not dual purpose, may be costly to provide to all students.

ADVANTAGES:

- Canadian technology.
- Supports graphic information.
- User-friendly.

DISADVANTAGES:

- Little practical software available.
- Special hardware in central location required.
- Expertise required for creating and maintaining databases.

INSTRUCTIONAL SUITABILITY:

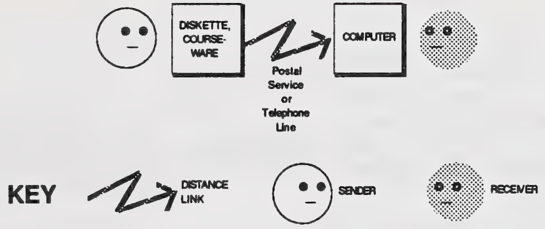
- Allows for individualized learning in that student controls the pace.
- Suitable for visual learning style.
- Assists with knowledge acquisition.

COMMENTS/ CONCERNS:

This mode has not really been accepted for instructional purposes. Recently, it has been used primarily for its graphics capability, in conjunction with other modes such as teleconferencing.

TECHNOLOGY MODE:

COMPUTER ASSISTED INSTRUCTION (CAI) COMPUTER MANAGED LEARNING (CML)



EQUIPMENT:

- Computer with monitor
- Disk drive
- Printer
- Software

COST CONSIDERATIONS:

- Costs for courseware development very high.
- Initial hardware and software costs high.
- Delivery costs low if through the Postal Service. Can be high if electronically transmitted.

ADVANTAGES:

- Interactivity between student and instructional material.
- Microcomputers provide flexibility with regard to time and place of learning.
- Tends to be self-paced.
- CML gives instructors access to test generation, test marking, and management and record-keeping facilities.

DISADVANTAGES:

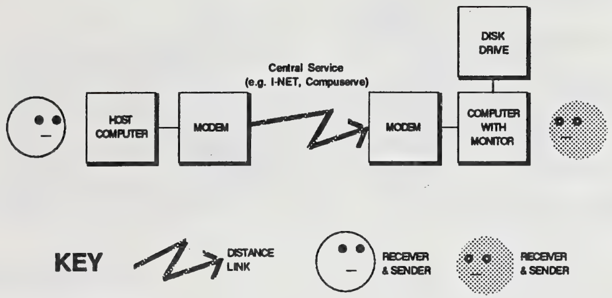
- In most cases, users must be trained. Higher level of expertise required by operators.
- Course information cannot be varied for individual instruction.

INSTRUCTIONAL SUITABILITY:

- Student can control pace of learning.
- Student can receive constant and immediate feedback. This type of feedback is different from that provided by an instructor.
- Poor students may not be able to cope with the amount of negative feedback they might receive.
- Emulates instructor-student relationship.
- Allows for learning through simulations.

COMMENTS/ CONCERNS:

TECHNOLOGY MODE:
COMPUTER CONFERENCING



EQUIPMENT:

- Central service (e.g. I-NET, Compuserve, the Source)
- Computers with monitors (all that is really required is a dumb terminal approximately $400.00 Canadian).
- Disk drives (optional)
- Modems

COST CONSIDERATIONS:

Long distance charges can be high in rural areas. However, these charges are lower than for audio teleconferencing.

ADVANTAGES:

- Emulates face-to-face instruction.
- Interaction with instructor and other students can be very intense.
- Instructor can control progress of session because s/he is able to monitor student responses.
- A great variety of information can be transferred: text, graphics, computer programs, data files.

DISADVANTAGES:

- Generally session specific as to time.
- More lead time required than for traditional mode of instruction.
- Users must be trained.
- More instructor time required than for other modes.
- Impersonal interaction.

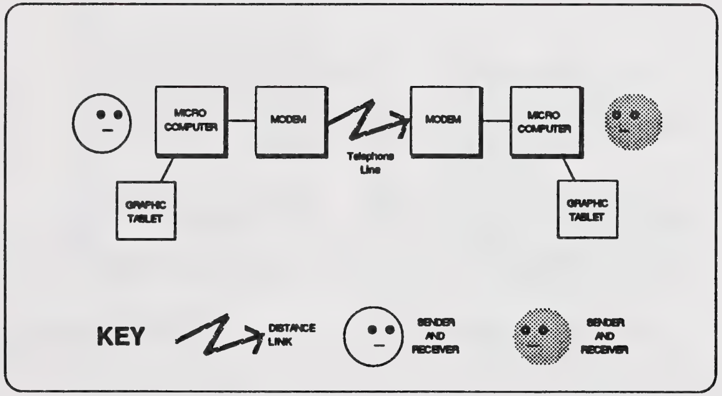
INSTRUCTIONAL SUITABILITY:

- Students can receive immediate feedback from instuctor.
- Particularly facilitates understanding of material.
- Suitable for imparting information and knowledge.

COMMENTS/ CONCERNS:

TECHNOLOGY MODE:

TELEWRITER, ELECTRONIC BLACKBOARD



EQUIPMENT:

- Micro computer
- Graphic tablets
- Modems

COST CONSIDERATIONS:

- Long distance charges can be high in rural areas. However, these charges are lower than for audio teleconferencing.

ADVANTAGES:

- Available for most computers.
- Allows remote blackboard-type interaction.
- Emulates face-to-face instruction.
- Interaction with instructor and other students can be very intense.
- Instructor can control progress of session because s/he is able to monitor student responses.

DISADVANTAGES:

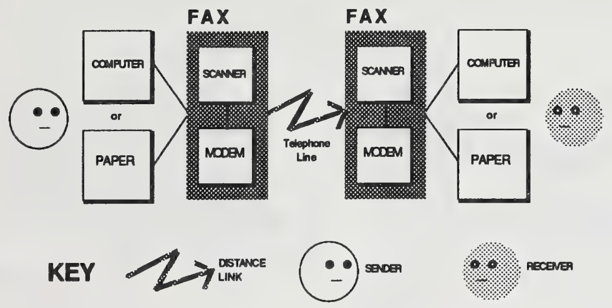
- Generally session specific as to time.
- More lead time required than for traditional mode of instruction.
- Users must be trained.
- More instructor time than for other modes.
- Impersonal interaction.
- Requires additional equipment at each station.
- Provides only written interaction unless coupled with audio connection.

INSTRUCTIONAL SUITABILITY:

- Student can receive immediate feedback from instructor.
- Particularly facilitates understanding of material.
- Suitable for imparting information and knowledge.

COMMENTS/ CONCERNS:

TECHNOLOGY MODE:
FAX (FACSIMILE TRANSFER)



EQUIPMENT:

- Facsimile machines.
- Telephone line for each facsimile machine.

COST CONSIDERATIONS:

- Facsimile machine costs $2,000.00 - $10,000.00.
- Line charges expensive if large amounts of data are transmitted.

ADVANTAGES:

- High speed and good quality of transmission.
- Practical alternative to postal and courier delivery for hard copy transfer.

DISADVANTAGES:

- High supply and line costs when transmitting large amounts of information.
- Limited to hard copy data transmission. Data cannot be manipulated.

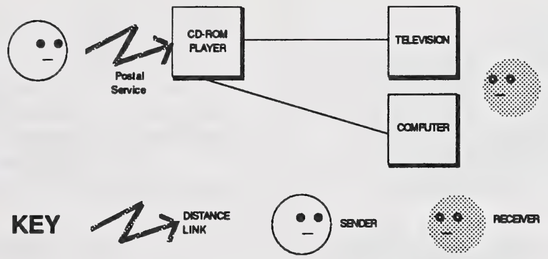
INSTRUCTIONAL SUITABILITY:

- Student receives feedback on assignments and tests in short time-period.

COMMENTS/ CONCERNS:

TECHNOLOGY MODE:

CD - ROM



EQUIPMENT:

- Disk used in conjunction with a computer.
- CD-ROM player.
- Television

COST CONSIDERATIONS:

- CD ROM player costs approximately $2,000.00.
- Costs of databases are high, inexcess of $1,000.00 per database.

ADVANTAGES:

- Great amounts of information can be made available locally on-line.
- Random access.
- Disks very reliable and have an expected life of at least 10 years.
- Handles still images well.

DISADVANTAGES:

- Limited storage of video images.
- Little available software.
- Write once, read many times (WORM) media.
- Disks cannot be erased and reused.

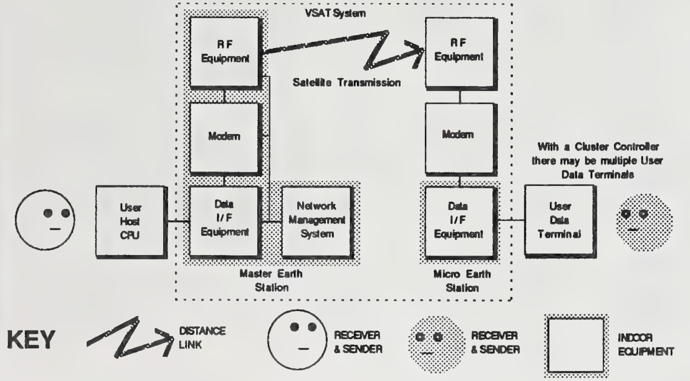
INSTRUCTIONAL SUITABILITY:

- Student has access to large volumes of information.
- Facilitates acquisition of knowledge and understanding of abstractions.

COMMENTS/ CONCERNS:

TECHNOLOGY MODE:

VSAT (Very Small Aperture System)



EQUIPMENT:

Components of a small-aperture satellite network typically include:

- a micro earth station
- satellite transponder capacity (a unit on the satellite receives a signal, converts it to the appropriate frequency and relays the signal back to earth).
- Network facility and management (includes a master earth station, a hub antenna and packet-switching electronics connected to a central computer).

COST CONSIDERATIONS:

- VSAT receiving transmitting dish costs approximately $8,000.00.
- One transmit/receive earth station can be leased for approximately $300.00 per month per location.
- VSAT terminals cost approximately $14,000.00 a unit.

ADVANTAGES:

- Bidirectional (one station for transmitting and receiving).
- Not limited to educational use. Can serve entire rural community, including businesses.
- Can be shared with other users to keep costs in line.
- Reduces dependence on long-distance telepone lines.
- Can increase the capabilities and performance of a data communications network.
- VSATs can be hooked up to existing data equipment or network architectures.
- Can broadcast information to all locations simultaneously.

DISADVANTAGES:

- A master earth station is a relatively expensive facility. Capital costs are a major consideration when moving to this satellite technology.
- Not portable or moveable.
- Relatively slow-speed video transmission.

INSTRUCTIONAL SUITABILITY:

Since these satellite earth stations facilitate data communication networking, they are not used directly for instruction.

COMMENTS/ CONCERNS:

4. QUALIFYING YOUR NEEDS

General Design Considerations

This section is intended to provide general guidance for the design of different types of distance education suites. Although much of this document focuses on specific workstation design requirements, the following points are meant to address the issues that should be considered for the zoning and wise use of space and technology within the context of the operation of an existing school. Within the context of an existing school, consideration must be given to the disruption and activities of a building alteration, whilst at the same time operating ongoing programs. This may have an important bearing on which space should be selected for upgrading.

Diagram Number One illustrates the general planning considerations for a distance education suite.

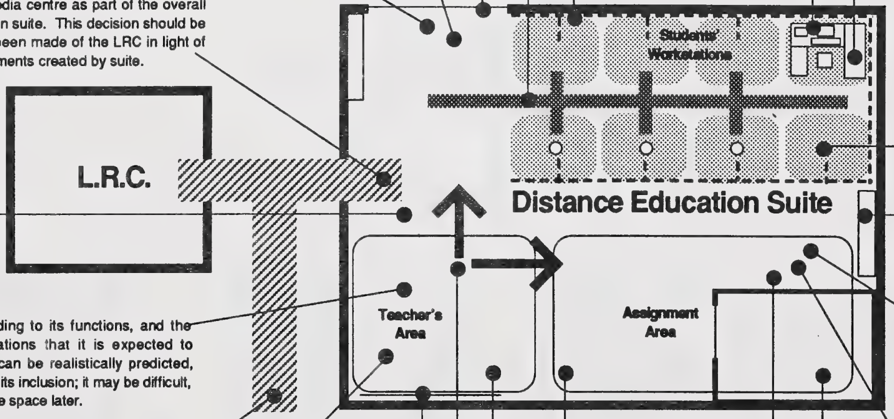
Diagram Number Two highlights other design considerations, especially those related to building services, controls and protection, as well as additional instructional and storage considerations.

Student Workstations

Although recommended standards exist for workstations used by adults, there is little information on their use by children. Since students vary from child to adult dimensions, it becomes impossible to recommend a set of dimensions that will comfortably apply to any student. As with adults, however, the solution lies in the selection of furnishings that will allow adjustments to suit user preferences. An added benefit of fully adjustable furnishings is that students with disabilities are able to use them too.

The factors indicated in Diagram Number Three are intended to be used as a general guide. It is expected that with added flexibility (for example, adjustments to a secretarial chair, or the swivel base under a video screen) the final degree of comfort for less than adult-sized students can be achieved. Physical immaturity brings with it stress related problems, especially if the student is required to sit rigidly for long periods.

Calculations of the number of workstations to be installed in each distance education suite will be based on scheduled use and number of hours of utilization.



The number, type and location of electrical and communication outlets must be determined by the variety of layouts that may feasibly be accommodated in the suite. Without careful consideration there is a risk that the circuits could become overloaded, and the suite will become a tangled web of power cables and extension cords.

The suite should be located in close proximity to the learning resources centre (LRC). Consideration may be given to upgrading the LRC to a multi-media centre as part of the overall planning of the distance education suite. This decision should be made after an assessment has been made of the LRC in light of increased media storage requirements created by suite.

The suite should be rectangular, rather than square, and free of partitions and high screens, thus offering unobstructed views to a standing person.

The suite must be sized according to its functions, and the numbers and types of workstations that it is expected to provide. If additional demand can be realistically predicted, then a case may be drawn up for its inclusion; it may be difficult, if not impossible, to add a bit more space later.

Proximity to other instructional areas is of secondary importance.

The room must allow for additional work area in which the student and teacher can interact on things which cannot be conveniently accomplished in the workstation. This area may be used by the teacher when addressing a group of students, or for group instruction activities, which may include the need for a large video screen. The teacher's workstation will be in this area.

Windows are generally a detriment, since direct sunlight presents an uncontrolled variable into the DES environment. This need not preclude a north facing window, if blinds or louvres can be provided for control of natural lighting.

The heating and cooling of the suite must be separate from the rest of the school, due to the heat build-up created by electronic equipment.

Chalkboards should be avoided. Whiteboards are not dust free, but are preferable.

The teacher's area will afford a clear view of the entire suite.

Master switches or controls for all equipment and lighting in the suite should be provided in the teacher's area.

Wherever possible, all power and communication connections should be made away from circulation routes, to minimize the risk of accidental disconnection and loss of data. Similar consideration must be given to the cabling patterns for a local area network (LAN) that may be required to connect equipment within the suite, and possibly elsewhere in the school.

The electrical services for the suite will be governed by the need to ensure that an appropriate number of clients are provided for the amount of equipment that will be utilized, together with the need for surge, spike and noise protection.

It is important that each student can work in comfort, and have relief from focusing on a fixed screen and the sense of containment within a carrel.

The workstation requirement for an individual distance learner will require more space than a regular student desk. Additional surface area will be required for technological equipment, as well as conventional writing area.

All finishes in the suite should be low gloss or non-reflective, and the use of very dark, very light, or bright (primary) colors should be avoided.

Laboratory/bench area, distinct from the student workstation, may be required for practical assignments.

It may be necessary to provide an enclosed booth for private study if conflict between individual and group activities is anticipated.

Different types of lighting should be available on a workstation by workstation basis, to facilitate different types of activities. This may include task lighting at desk level. Preferably, lighting should be controlled from the teacher's area.

Shelves, bulletin boards and millwork (including lockable storage space) should be provided to support the activities and equipment in the suite.

Space must be flexible, and able to accommodate emerging (and as yet unknown) technologies. Flexibility, in construction terms, infers additional cost.

Consider the disruption that building alterations will create to the ongoing operation of the school. It may affect your choice of location.

The DES is *not* a classroom made available for computers. Neither should it be considered a space where surplus desks and tables may be brought to good use.

DIAGRAM ONE: GENERAL PLANNING CONSIDERATIONS FOR A DISTANCE EDUCATION SUITE

Temperature and relative humidity fluctuations should be minimized. Pre-programmed temperature changes can cause problems. Air conditioning will be required to maintain a constant temperature. Temperatures in the 20° - 22°C range should be maintained.

Telephone (data) lines to modems must be direct, and not pass through the school switchboard. Regular telephone (audio) lines should be routed through the switchboard.

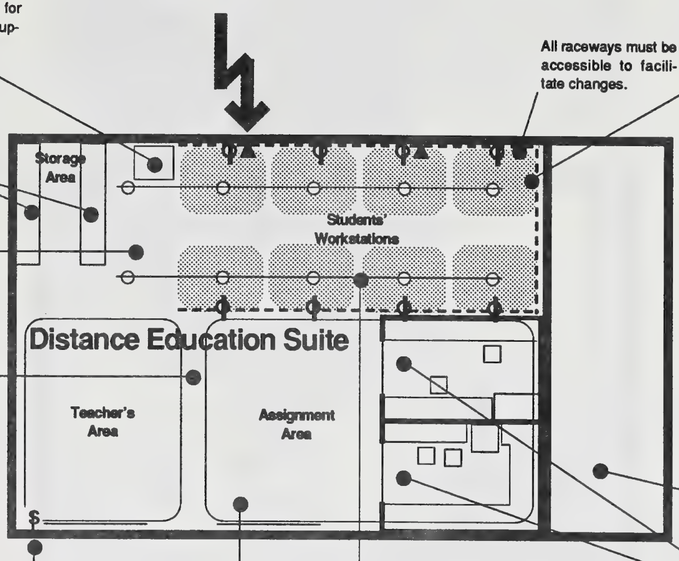
Dust is an enemy. Its presence can cause equipment problems. These problems can be reduced by electronic filters, a separate ventilation system from the remainder of the school, sealed windows, and a tightly fitting door which is kept closed: One ounce of prevention of dust related problems is the provision and use of dust covers for all equipment.

A dedicated telephone line should be provided to each modem in the DES.

Uninterruptible power supply should be considered for key equipment where data loss through power interruption would cause significant recovery costs.

All raceways must be accessible to facilitate changes.

Electrical raceways that serve a workstation will probably carry cables for regular power, clean power, telephone and local area network. Consideration for the electrical service distribution pattern must include relative economics of floor, wall and ceiling distribution, in light of the nature of the existing building fabric and the resulting premiums for different types of building alterations. As a general rule, avoid using power poles, unless they are placed against walls.



Lockable storage should be placed outside of the workstation if it is not dedicated to a particular student.

Anti-static floor covering should be used. Carpet is desirable because of its acoustic quality.

The DES must be protected by intrusion alarms.

Do not use a sprinkler system in the DES. Halon-type fire extinguishers should be installed. Smoke can cause serious damage to electronic equipment, so the alarm systems should automatically close DES doors. The mechanical system should not permit the mixing of air from the rest of the school with the DES and should cut off air circulation to the DES in the event of heat or smoke. Materials should be non-combustible wherever possible; if not, fire resistant.

Computers should be provided with clean power as protection against spikes, surges, and noise.

Computer power supply and isolated grounding should be provided from a main power panel.

Adjacent rooms should not allow equipment with strong magnetic fields or that emit large amounts of RF (Radio Frequency) interference.

Master switching for computers should be located within the DES, with key controls in the teacher's area to prevent accidental or malicious shutdowns.

Although expensive, full spectrum lighting should be used if fluorescent lighting is proposed, since it helps to reduce eye strain.

Small group activities, undertaken away from the student workstations (phone conferencing, for example) will require additional communications equipment

If distance education courses require assignments that will be disruptive, noxious or damaging to technical equipment (requiring water or gas for example) and it is impractical to schedule the use of regular school space, the DES may include small laboratory or bench areas, physically separated from the main area (but visible from the Teacher's Area)

DIAGRAM TWO: GENERAL DESIGN CONSIDERATIONS FOR A DISTANCE EDUCATION SUITE

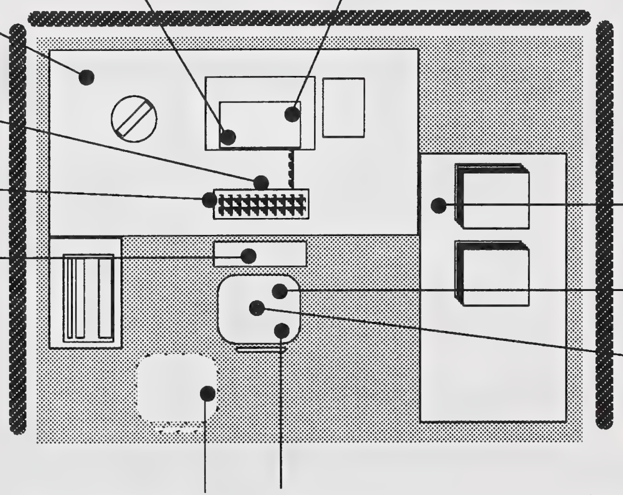


DIAGRAM THREE: GENERAL DESIGN CONSIDERATIONS FOR A STUDENT WORKSTATION

Reflective glare from a video screen may be avoided by use of a screen hood; the placement of an anti-glare filter over the screen; the recessing of ceiling light fixtures; the use of baffles to diffuse light downwards; the use of an indirect lighting system, or the use of parabolic diffusers to reduce ceiling glare.

Muscle strain, eye strain, sore neck and sore joints can easily result from improper furnishings. The furniture must be flexible, and capable of adapting to a variety of configurations (according to tasks and combinations of equipment) and different sized users (ranging from child to adult).

The keyboard should be located straight ahead of the user. Its height should be between 720 and 790 mm.

The keyboard height, relative to the seated user must allow the user's elbow to be flexed at an angle of 80 to 120 degrees.

A footrest should be considered for short users.

As a general rule, avoid planning for two students in one workstation.

Different types of lighting (task lighting, recessed ceiling lighting) should be available at each workstation.

The luminance ratio within the student's field of vision should not exceed 1:3 over the desk area, or 1:10 elsewhere in the room.

Finishes should be non-glare. Mid tones should be used to avoid contrast and eye strain when using the video screen and printed material. Dark tones and bright colours should always be avoided. Ideally, the screen will present no glare or reflection. The position of lighting is critical in this consideration since the screen may reflect ceiling lights. Preferably, the screen may be tilted to suit the user's posture.

In determining furnishing configurations, consideration should be given to the occasional joint use of the workstation by the student *and* the teacher.

The video screen must be correctly positioned. The viewing distance should be adjustable to each student's need. Generally, this will require it to be 450 to 700 mm from the user, allowing a full view of the screen, with limited eye movement. The height of the screen will be 10 to 20 degrees below horizontal view.

Lighting levels will be generally lower for video screen users than for readers. General lighting levels for reading might be 800 lux, whereas 400 lux would be comfortable for the screen user. Task lighting may be required for a student referring to screen and print material.

Opinions vary on the correct height for seating. The minimum range should be 380 - 535 mm. The seat pan should be adjustable so that the user can adopt a knee bend angle of approximately 90 degrees. The pan should be approximately 400 mm, front to back, and 495 - 545 mm wide. An adjustable back rest (capable of adjusting down to 80 mm) is required for lumbar support

Each workstation must be large enough to hold not only a microcomputer, but also the video console, disk drive and/or hard drive, and (possibly) other peripheral equipment. Wherever possible, peripheral devices should be shared through a network to optimize their use and space requirement.

Writing surfaces should be between 820 and 900 mm.

The seat covering must be non-slip and permit air circulation.

The seat should rotate and have a five castor base.

All furnishing adjustment controls should be easy to operate and unobtrusive.

It is important that each student can work in comfort, and have relief from focusing on a fixed screen and the sense of containment within a carrel.

5. DATA SHEETS

This section introduces the more detailed planning considerations for the *layout* of the D.E.S., whereby the designer can consider the merits of various configurations, based on individual school needs.

There are three major components of the D.E.S. within this concept. These are:

- Student Workstations
- Assignment Area
- Teacher's Area

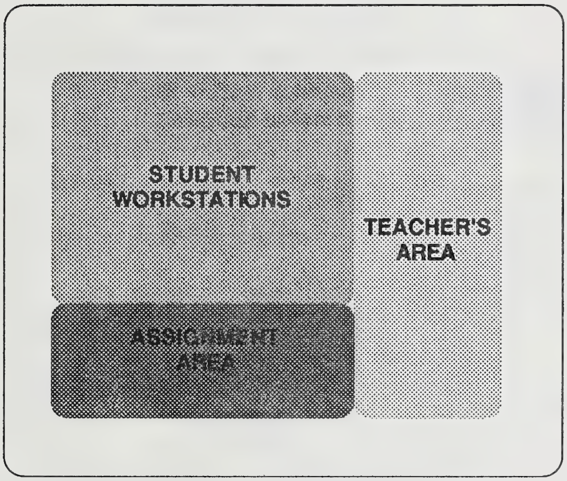


DIAGRAM FOUR
COMPONENTS OF THE DISTANCE EDUCATION SUITE

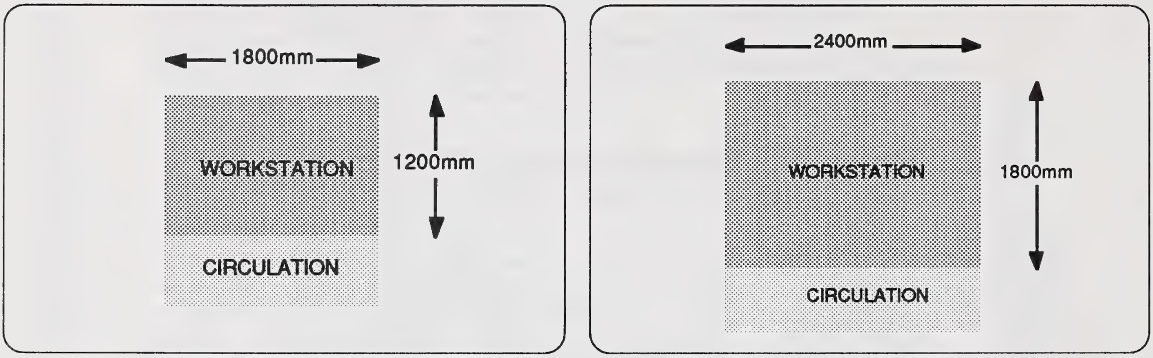
Student Workstations

Perhaps the most important of these components are the individual student workstations, since they provide the setting for distance education proper. Although the workstations are illustrated in greater detail later in this section, the reader should appreciate that what is shown is not "scribed in stone": technology is advancing so fast that within a few years the ideas expressed may well be obsolete. In consideration of this factor, the workstations are rationalized on a 600 mm grid, whereby future requirements (based on new technologies) may be applied to the two basic configurations that we have adopted. The advantages of this include:

- Ongoing flexibility in the ways in which the workstations and the D.E.S. can be utilized.
- The 600 mm grid fits with the 1200 mm and 2400 mm standard dimensions of modular floor and ceiling products, and many other building materials.
- The adoption of the planning grid within an open rectangular area encourages the development of a predominantly open plan: free from obstruction, and capable of future change without major renovation costs.
- A convenient way in which the potential areas for the D.E.S. can be assessed within an existing school, slated for renovation, or a new school design.

Module Types

There are two recommended types of individual workstations for student use:



Type A

Type B

DIAGRAM FIVE
WORKSTATION MODULES

Note, 600 mm circulation area, when doubled in face-to-face configurations will provide a 1200 mm passage between workstations.

The characteristics of the modules are as follows:

Type A

Net Area	Gross Area	Technology Modes
2.16 m^2	3.24 m^2	Print Audiocassette Television Telewriter C.A.I. Computer Conferencing

Type B

Net Area	Gross Area	Technology Modes
4.32 m^2	5.76 m^2	Videocassette Videodisc Videotex CD ROM

These are illustrated on the following five pages.

Instructional Mode **Print**

Workstation Type **A1**

Net Area: 2.16m2

Gross area: 3.24m2

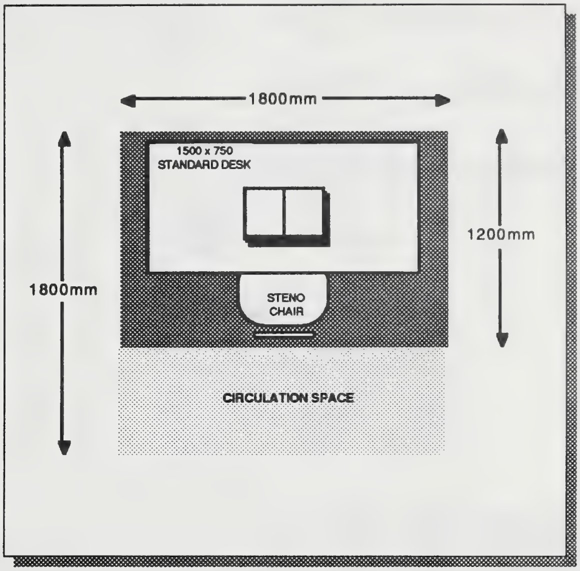


DIAGRAM SIX

Instructional Mode **Audiocassette**

Workstation Type **A2**

Net Area: 2.16m2

Gross area: 3.24m2

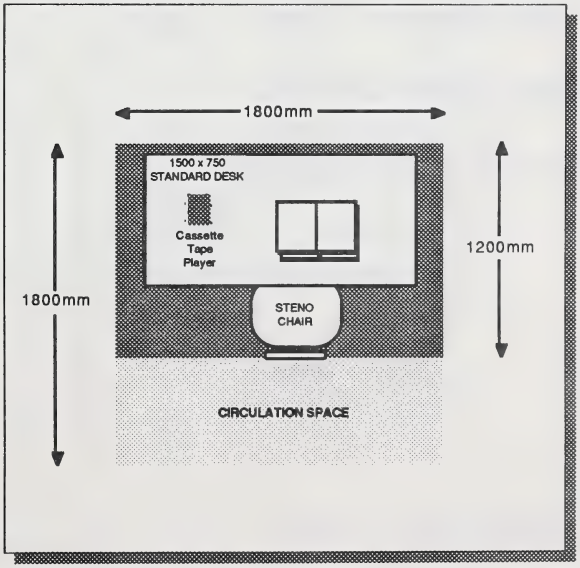


DIAGRAM SEVEN

Instructional Mode **Television**

Workstation Type **A3**

Net Area: 2.16m2

Gross area: 3.24m2

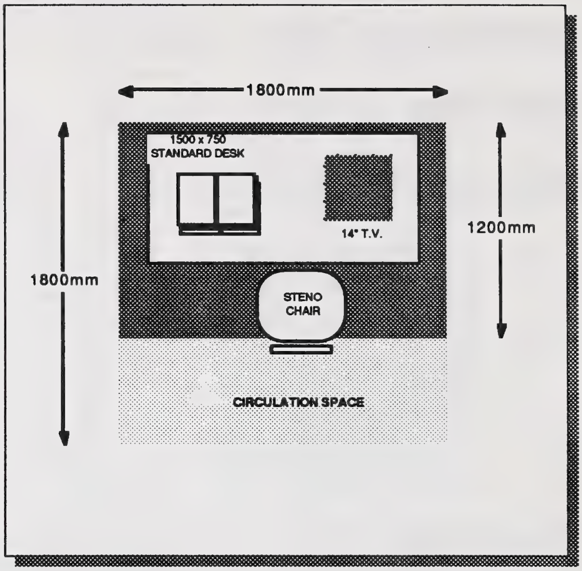


DIAGRAM EIGHT

Instructional Mode **Telewriter**

Workstation Type **A4**

Net Area: 2.16m2

Gross area: 3.24m2

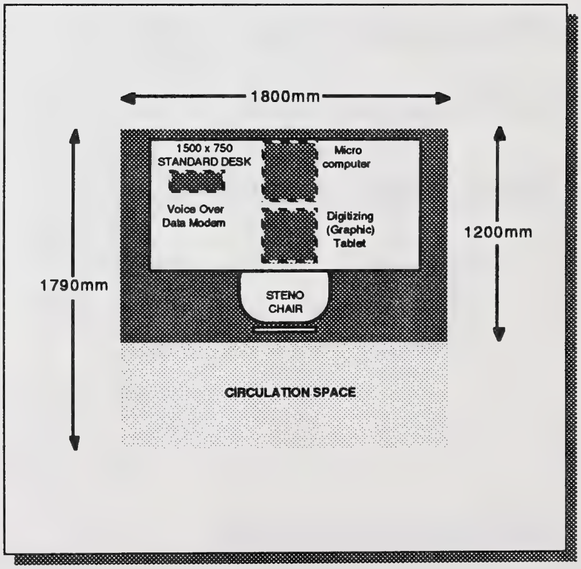


DIAGRAM NINE

Instructional Mode **C.A.I.**

Workstation Type **A5**

Net Area: 2.16m2

Gross area: 3.24m2

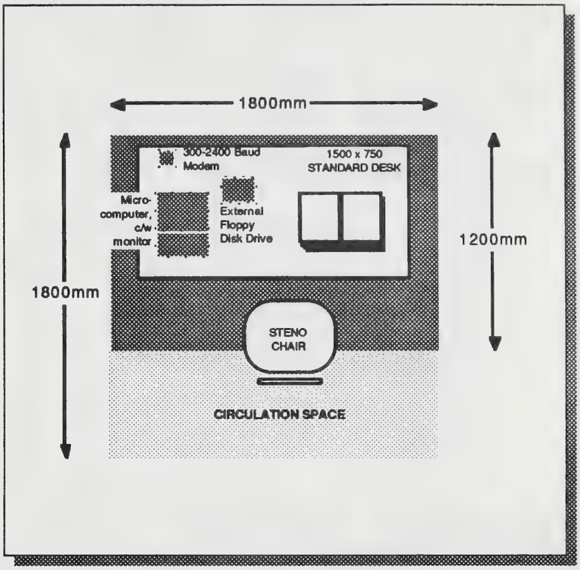


DIAGRAM TEN

Instructional Mode **Computer Conferencing**

Workstation Type **A6**

Net Area: 2.16m2

Gross area: 3.24m2

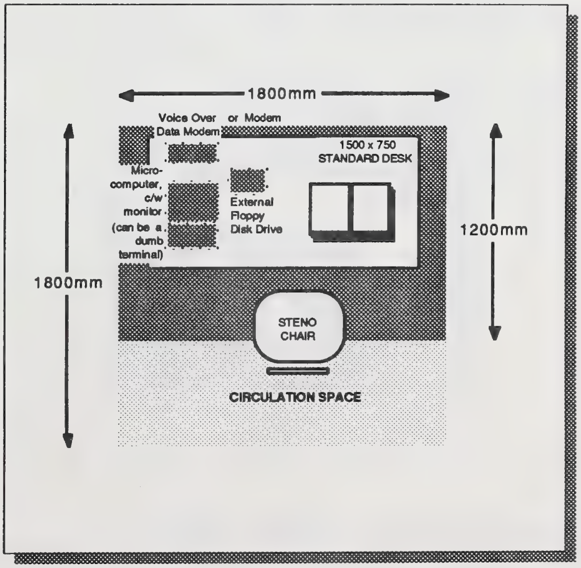


DIAGRAM ELEVEN

Instructional Mode **Videocassette**

Workstation Type **B1**

Net Area: 4.32m2

Gross area: 5.76m2

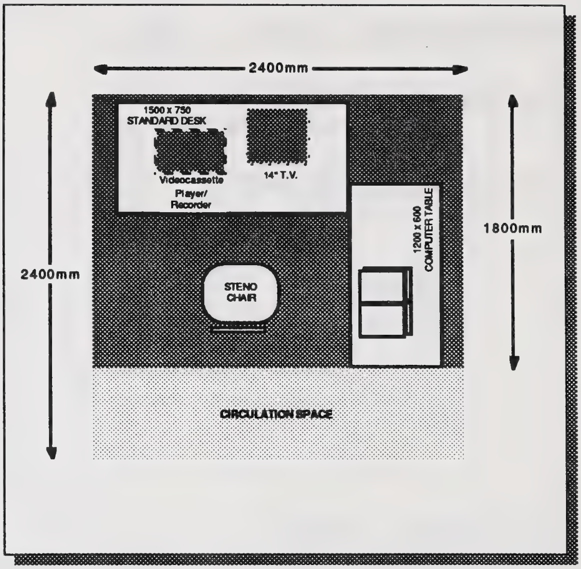


DIAGRAM TWELVE

Instructional Mode **Videodisc**

Workstation Type **B2**

Net Area: 4.32m2

Gross area: 5.76m2

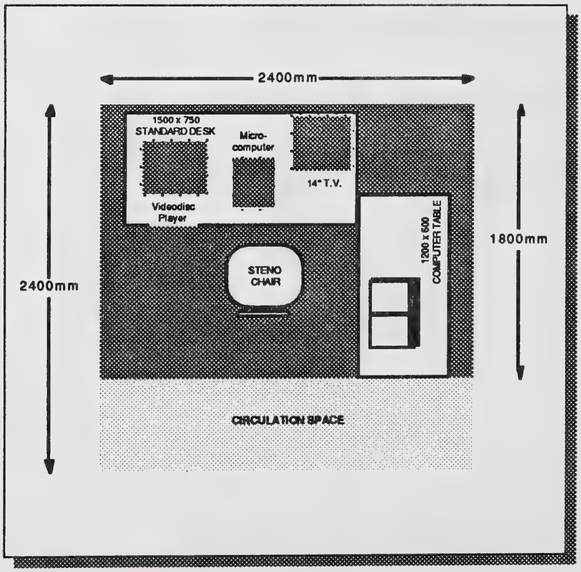


DIAGRAM THIRTEEN

Instructional Mode **Videotex**

Workstation Type **B3**

Net Area: 4.32m2

Gross area: 5.76m2

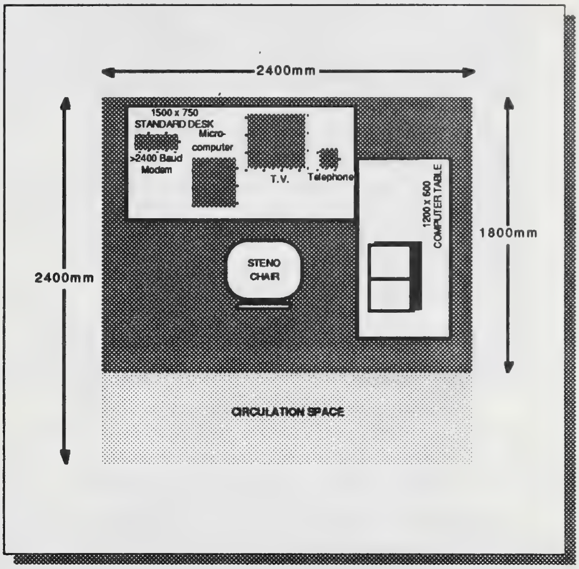


DIAGRAM FOURTEEN

Instructional Mode **CD-ROM**

Workstation Type **B4**

Net Area: 4.32m2

Gross area: 5.76m2

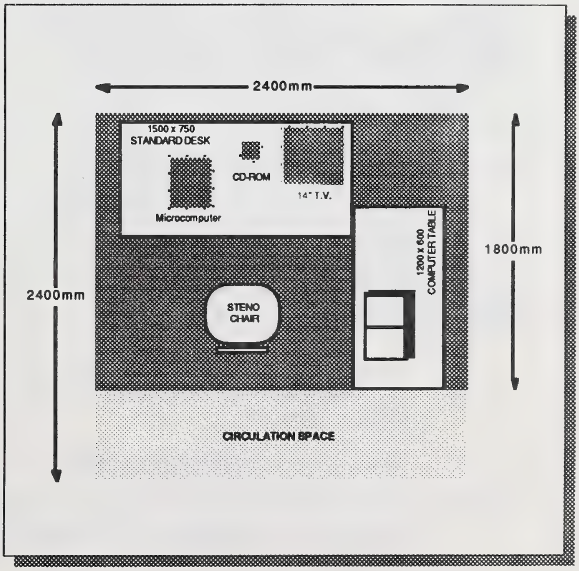


DIAGRAM FIFTEEN

Assignment Area/Booth Area

The assignment area will provide a laboratory/bench area where students may complete practical assignments in conjunction with the distance education course. This will be necessary in situations where students find it impossible to schedule their individual needs in regular classroom/laboratory space in the school. In such instances, the student would schedule use of the assignment area with his teacher.

Noxious or disruptive work should be housed in booth areas. Booths should be designed and equipped according to the course requirements as determined by local demand, and to the greatest extent possible service multi-use functions. This does not include the merging of mutually exclusive courses (i.e. Biology and Home Economics) into the same booth area, nor does it propose that an Industrial Arts shop (for example) be considered as an integral part of the Distance Education Suite.

Teacher's Area

The Teacher's Area provides a basis for several activities:

- Surveillance of the Distance Education Suite, whereby all of the suite's activities can be clearly viewed.
- Monitoring and controlling entry and exit from the Suite.
- Master controlling of all systems in the suite, including power, lighting, and environment.
- Storage of equipment that may not require regular use.
- Individual instruction, as required.
- Small group instruction, whereby supplementary instruction may be given to student(s) in support of their distance education courseware.
- Group conferencing (computer, audio and video).
- Coordinating the activities within the Suite.
- The provision of space for the operation of peripheral devices (printers, scanners, etc.) run in conjunction with hardware in the student workstations.

Recommended areas for Teacher's Area are as follows:

Teacher's Area	m^2
Four Student	20.16
Six Student	22.68
Eight Student	25.20
Ten Student	27.72
Twelve Student	30.24
Fourteen Student	32.76
Sixteen Student	35.28
Eighteen Student	37.80
Twenty Student	40.32

Layouts for four and eight student areas are shown in Diagrams 16 -19.

Storage

Provision should be made for students to store distance education related material. This should not be construed as a student locker for regular (school based) education, but rather as a storage amenity, under the student's control, where partially completed assignments, courseware, and books directly related to activities in the suite can be kept safely. Each student should be assigned a 600 x 600 x 600 mm lockable storage cupboard. Storage area is considered as part of the circulation area in the planning formula shown later in this section under "Planning Guidelines".

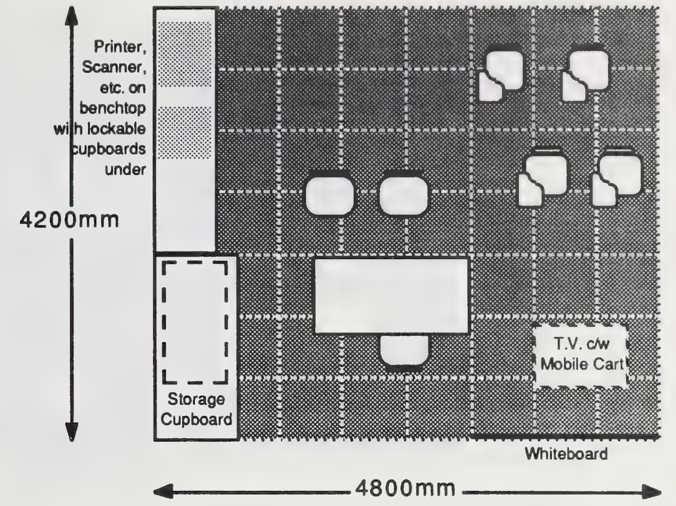

Printer, Scanner, etc. on benchtop with lockable cupboards under
4200mm
Storage Cupboard
T.V. c/w Mobile Cart
Whiteboard
4800mm

DIAGRAM 16
TEACHER'S AREA FOR FOUR STUDENTS
VIDEO OR VIDEO TELECONFERENCING

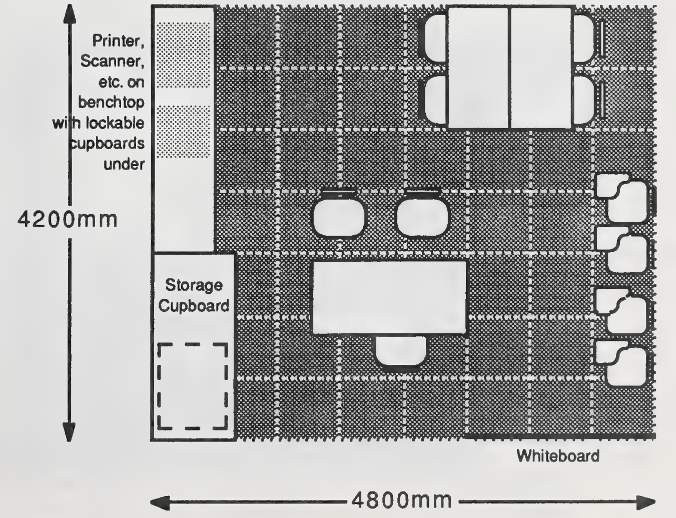

Printer, Scanner, etc. on benchtop with lockable cupboards under
4200mm
Storage Cupboard
Whiteboard
4800mm

DIAGRAM 17
TEACHER'S AREA FOR FOUR STUDENTS
AUDIO TELECONFERENCING

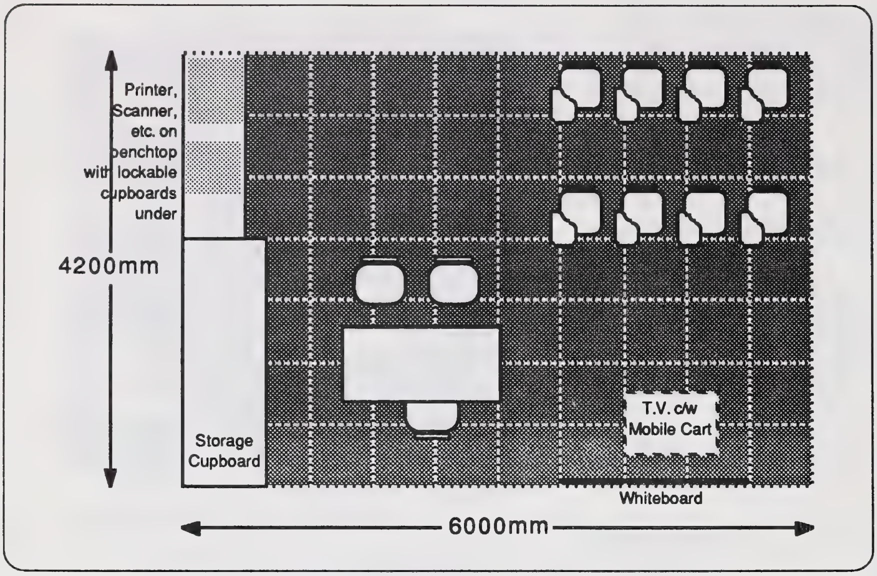

Printer, Scanner, etc. on benchtop with lockable cupboards under
4200mm
Storage Cupboard
T.V. c/w Mobile Cart
Whiteboard
6000mm

DIAGRAM 18
TEACHER'S AREA FOR EIGHT STUDENTS
VIDEO OR VIDEO TELECONFERENCING

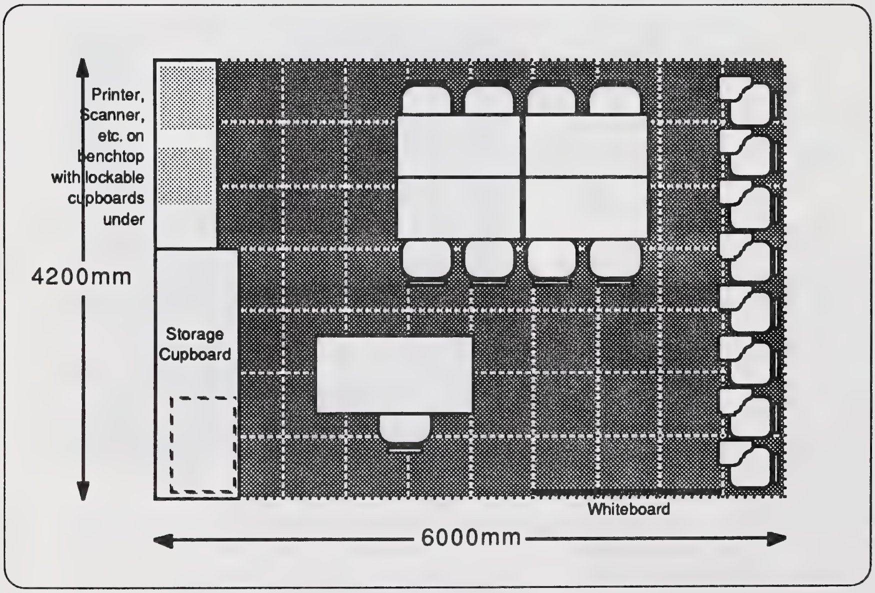

Printer, Scanner, etc. on benchtop with lockable cupboards under
4200mm
Storage Cupboard
Whiteboard
6000mm

DIAGRAM 19
TEACHER'S AREA FOR EIGHT STUDENTS
AUDIO TELECONFERENCING

Planning Formula

The area for the D.E.S. must be rationalized on the basis of need for, and utilization of the types of technology modes and the number of students requesting instruction in subjects selected for distance education. Accordingly, we are recommending a process whereby the total area of the D.E.S. can be calculated. The recommended factors (or percentages) are not based in research, but more on intuition. As later illustrations show, they seem to work. We believe that they are fair, but that they should be confirmed by *experience* and modified if necessary. The formula we recommend is as follows:

D.E.S. Gross area (m^2) =X+Y+Z+CS.

where **X** is the gross area (m^2) of the Student Workstations

Y is the net area (m^2) of the Teacher's Area*

Z is the net area of the Assignment Area, calculated as 0.5 X

CS is the area allowed for Circulation Space, calculated as 0.3 (Y+Z)

* Refer to Diagrams 16-19 for four and eight student layouts. The number of students in the Teacher's Area should be two-thirds of the number of student workstations in the DES (minimum size for four students), rising in increments of two students, ie. 12 workstations will require an eight student Teacher's Area, 6 workstations will require a four student Teacher's Area, 10 workstations will require an eight student Teacher's Area, etc.

The formula is demonstrated in the two following examples:

Six Station Distance Education Suite:

		Area (m^2)	
(Presume)	3 Workstations Type A	9.72	X
	3 Workstations Type B	17.28	
	Teacher's Area (for 4 students)	20.16	Y
	Assignment Area (50% of workstations)	13.50	Z
	Circulation (30% of T.A. plus Assignment Area)	10.10	CS
	TOTAL:	70.76 m^2	

This is schematically illustrated in Diagram 20.

Twelve Station Distance Education Suite:

		Area (m^2)	
(Presume)	6 Workstations Type A	19.44	X
	6 Workstations Type B	34.56	
	Teacher's Area (for 8 students)	25.20	Y
	Assignment Area (50% of workstations)	27.00	Z
	Circulation (30% of T.A. plus Assignment Area)	15.66	CS
	TOTAL:	121.86 m^2	

This is schematically illustrated in Diagram 21, and elaborated as a furnished plan in Diagram 22.

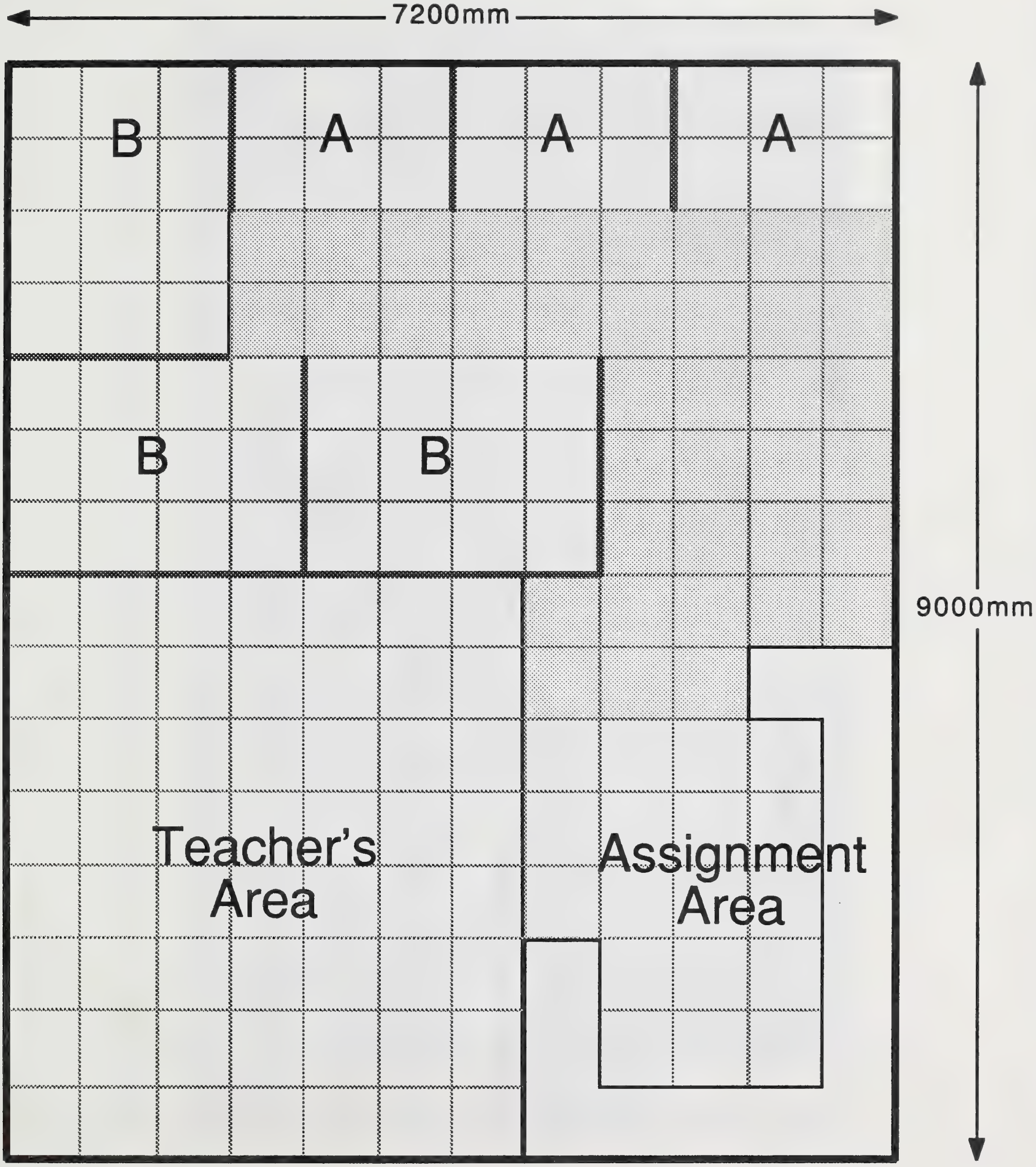


DIAGRAM 20
A SIX WORKSTATION SUITE

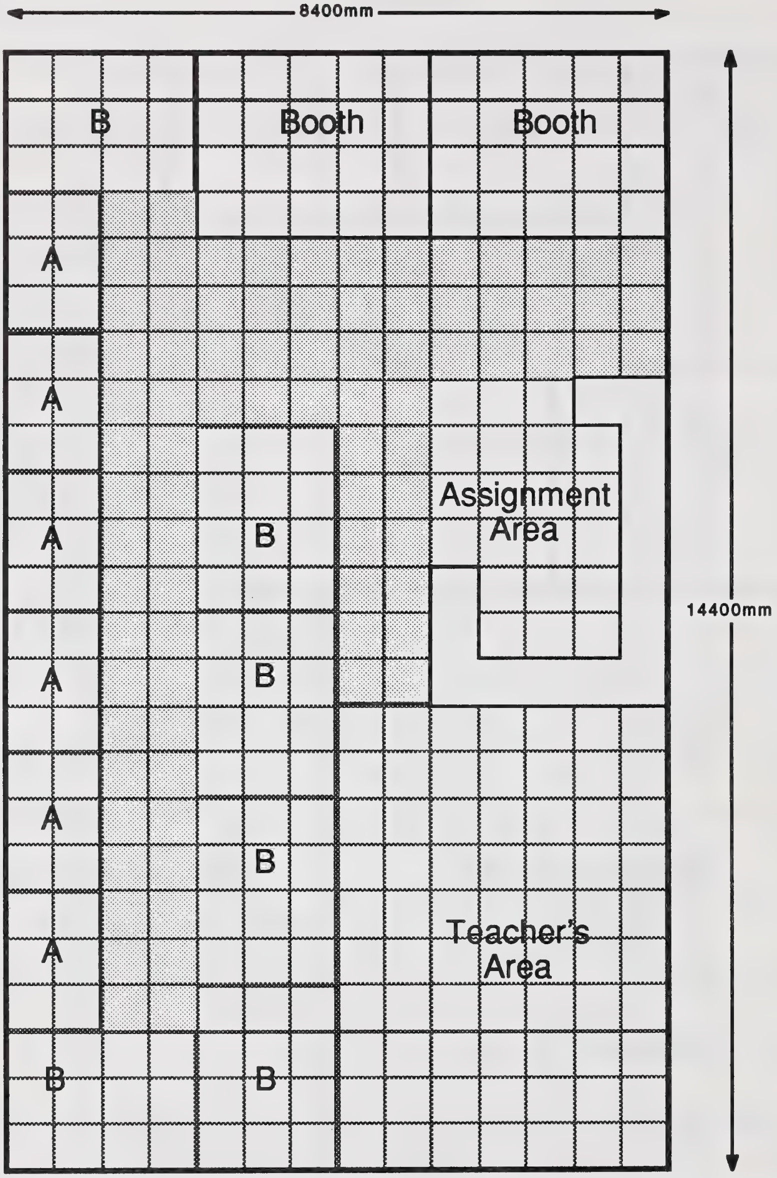


DIAGRAM 21
A TWELVE WORKSTATION SUITE

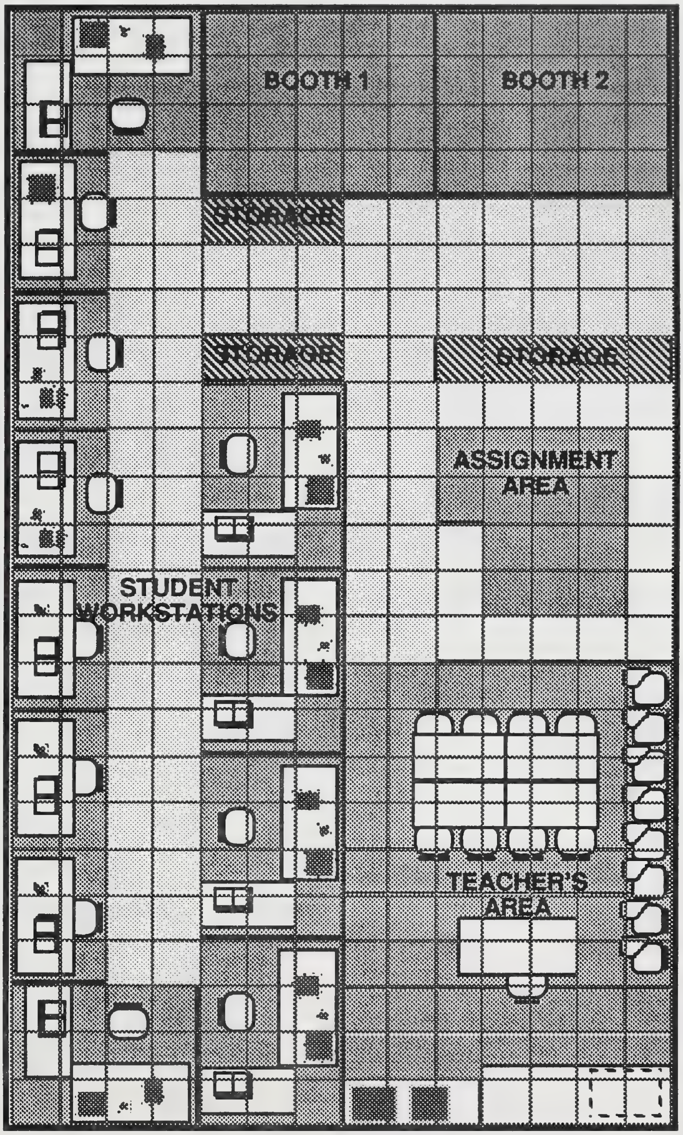


DIAGRAM 22
TWELVE WORKSTATION SUITE:
A FURNISHED LAYOUT

6. BUILDING COST IMPLICATIONS OF DISTANCE EDUCATION

Construction Cost

It is clear that the spatial and environmental requirements for technology based instruction vary considerably from conventional school space. Alberta Education has already established support prices (cost/m^2) for new and restorative construction. The cost analysis undertaken in this study has presumed the provision of regular funding for the area required by the D.E.S., and addresses the *premium* (i.e. the additional funding requirement) of the higher standard of construction that must be considered.

The quality and type of construction materials included in the Quantity Surveyor's calculations (see Appendix 2) allow for durability, suitability and flexibility. The unit prices for architectural, mechanical and electrical materials make it possible to design a D.E.S. that will be able to evolve with technology, certainly over the next decade.

Based on the two Distance Education Suites illustrated in the previous section (71 m^2 and 121 m^2), prices have been allocated, by element, in a summary cost plan which expresses the *additional* support that should be provided for the construction of a D.E.S.

Please refer to the scope in Appendix 2 for a summary of the cost study assumptions.

The additional costs are summarized below:

	Additional Cost/m^2 Based on a Program Area of 121 m^2	**Additional Cost/m^2 Based on a Program Area of 71 m^2**
TOTAL REQUIREMENT	**\$910.00/m^2**	**\$1,010.00/m^2**
BASIC REQUIREMENT	**\$606.00/m^2**	**\$673.00/m^2**

That is to say, the additional support for these two theoretical facilities would be about \$110,000 and \$72,000 respectively.

By interpolation it will be possible to establish a support price which will take into account some marginal advantage resulting from the economy of scale.

Equipment Cost

It is extremely hard to pin down the cost of equipment. Much depends on the speed of the equipment, the type of software being utilized, the including of hard disk drives, the configuration of the equipment and the peripheral devices that may be included in the DES. There is no rule of thumb that will conveniently apply.

Based on discussions with key informants and with equipment suppliers, we have compiled the following list of current prices:

Computer	
A low end educational machine	$1,200 to $1,500
A high end personal computer (MAC II, IBM PS280)	$8,000 to $10,000
Networking:	
AppleTalk network (Macintosh) including software, about	$350 node
CORVUS (including hard disk drive) about	$3,000
plus a card in each computer costing	$800 to $1,200
for MSDOS machines or	$600 to $700
for Apple *IIe*.	
FAX Machine: ($95/month for 3 years rent-to-purchase)	$3,500
Teleconferencing Convenor:	$1,400
Satellite Dish: each	$2,000
Scanner:	$3,000
Computer Modem:	$250
CD ROM: Player	$2,000
Database	$1,000
Compact Disc: Player	$300
Television:	
High resolution 25" monitor c/w speakers ea.	$2,000
Dot Matrix Printer:	$600
Laser Printer:	$6,000
Teleconferencing Bridge:	
(hourly rate)	$100
Note: this cost would be shared by all network users, rather than be charged to one school.	
Long Distance Charges:	
Re: Small Schools Project Expected to be $2,000 per site/ per year, including FAX transmission and telephone conferencing.	

Amortization and Maintenance Costs

Most high-technology products are reliable for a period of 5 to 10 years. We recommend that (for budget purposes) they be amortized over five years. Additionally, 1%/month for the life of the equipment should be budgeted for maintenance. This is a conservative (i.e. high) estimate, but since there is no history of current high technology maintenance costs, we believe that it is prudent to err on the high side.

Furnishings Cost

Furnishing requirements will vary with each installation. Built-in storage and cabinet work has been included in the cost estimate, so the remaining requirement is for free-standing desks, chairs, and tables (all of which should be adjustable), and dividing screens between workstations. For budget purposes, we recommend $1,500.00 per workstation, including the Teacher's Area, which should be counted as one workstation.

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APPENDIX 1

Overview of Technology

Communications

Data Communications

Description	Advantages	Disadvantages
Packet Switching Networks	Low cost over large distances. Readily accessible in most major centres. World-wide access to information. Provide gateways to both information utilities and other packet switching networks. Excellent for computer conferencing.	Accessible in remote areas only by long distance calls. Presently operate at max. 2400 baud through dial-up ports.
Dedicated conditioned lines	Insures constant line access. Able to handle higher speed transmission than dial-up lines.	Expensive in the long term. High monthly charges. Requires high usage to be viable.
Microwave Transmission	Insures constant line access.	May not be available in remote areas. Requires additional equipment. Line of sight access.
Satellite	Available in remote locations.	Satellite link causes 3 to 4 second delay in response. Expensive unless heavily used. Requires additional equipment on each end.

Information Utilities

Description	Advantages	Disadvantages
Source/ Compuserve	Provides ready access to large amounts of information. Set up to allow for easy computer conferencing. Mail services as well as online storage available.	High per hour access cost. ~$20.00 U.S. Require sign on passwords. May be hard to control access once passwords known.
Bulletin Boards	Good for providing ongoing information updates. Low cost to implement. Under full user control. May be used as a mail drop.	Limited capability.
Telidon Videotex Information Service Used on Canada AM for Weather	Supports graphic information. Canadian technology.	Little practical software. Never really caught on. Requires special hardware to function.
Minitel	Wide user acceptance in France. Only successful videotex system in the world. Terminals free, access charged.	Only available in France. Expensive when used heavily.

Communications

Voice

Description	Advantages	Disadvantages
Telephone	Readily available. Ease of use. Able to support conference calls.	When used over long distances can get expensive. Impersonal. No visual contact.
Radio	Relatively inexpensive as no line charges. Excellent for extremely remote areas.	Lower transmission quality. (Good FM and SSB) Requires radio equipment on each end. Requires a certain level of expertise. Impersonal. No visual contact.

Video Transmission

Description	Advantages	Disadvantages
Satellite	Able to serve remote areas. Can handle voice and data transmission. Current technology.	Requires receiving equipment for uni-directional operation. Requires both receiving and transmission equipment for bi-directional communication. Fairly expensive.
Cable Television		Not generally available outside of large centres.
Regular Television	Area of availability larger than cable systems.	Commercial in nature. Expensive.

Voice, Data, Video Transmission

Description	Advantages	Disadvantages
Phone Lines	Readily accessable. Relatively inexpensive. No additional lines or equipment required.	Maximum speed of data transmission limited to ~9600 baud. Line charges when used heavily are costly. In some areas line quality is low. Can't handle more than one form of data a a time. (Possible exception is voice and data though technology is new)
Fiber Optics (T1 lines)	Faster transmission speeds. High qualitylines. Can handle voice, data, and video simultaneously. The up and coming technology. Data transmission speed to 56k baud.	Not readily available in most locations. 10 years away in rural Alberta.

Video		
Video Transmission		
Description	**Advantages**	**Disadvantages**
Cable Television	Large established network of subscribers. Relatively low cost for usage. Production facilities available through the cable company.	Available only in larger centres. Owned by a third party so access must be arranged. Long lead times for program scheduling.
Satellite Television	Able to serve very remote areas. Access to signal can be restricted. If access is bi-directional, one connection can handle audio, video and data transmission. Excellent for teleconferencing.	Requires a satellite receiving dish at one end. If transmitting independently require transmitting facility. Long lead times to arrange programming. If two way communication required, transmitting equipment required on both ends.
Regular Television	Relative to cable, has a large transmission area. Production facilities available.	Tends to be commercially orientated. Long lead times to arrange programming. Expensive. Cannot limit velwing audience
Video Mediums		
Description	**Advantages**	**Disadvantages**
Video Tape	Low cost of medium. Read/Write capability. Readily available. Large selection of materials. Familiar to most individuals. Long recording time, 4-6 hours.	Sequential Access. Poor hanlding of still images. Does not integrate well with computer technology. Image degrades with use.
Video Disc	Random access. Handles still images well. Works well with computers. Extremely reliable medium. No degradation of image with usage. Low cost of final product.	Non-recordable media. Limited availability of software. Not highly accepted technology. High cost of production. Playing time short compared to video tape.
CD-ROM, CD/I	Random access. May in future become the standard medium for computers, audio and video. Gaining commercial acceptance. Handles stills well.	Limited storage of video images. 54,000 frames, or ~ 1/2 hour. Little available software. Write once read many times media. Very new technology.

Computers

Input Devices

Description	Advantages	Disadvantages
Keyboard	Most common method of communicating with the computer. Required for text entry. Standard equipment.	Slow. Hard for people with no typing skills.
Mouse	Newer technology. Gained wide acceptance recently. Reduces the level of skill required for computer use. Excellent for graphics input.	Not widely supported on some computers. Limited accuracy.
Graphic Scanners Some can attach to Printer	Allows the computer to capture graphic data. Resolution of 300 dpi. Good for desktop publishing.	Expensive >$2000.00. Limited use in most situations.
Optical Character Readers As above	Allow reading of printed material into the computer.	Expensive. Technology still rudimentary. Requires fast processing and large memory.
Voice Input	Allows voice control of the computer.	Limited software available. Technology still poor. Needs to be trained for each user. Requires a large amount of memory and processing power.
Video Input Devices	Allows the transfer of video images to the computer.	Handles video images as stills.
Card readers	Good for test and survey result compilations.	Older technology. Requires punched cards. Can be touchy over time.
Digitizing Tablets Foot print dependent on active area	Valuable input device for CAD/CAM work. Can be set up to function with other software.	Limited application in other areas. Generally a fairly expensive input option. Functional with a limited range of software.
Telewriter	Allows remote black board type interaction. Available for most computers.	Requires additional equipment at each station. Provides only written interaction unless coupled with audio connection.

Computers		
Printers Continued		
Description	**Advantages**	**Disadvantages**
Laser Printers - Post Script as above	As above. Excellent graphics capability. Often shared among several users.	Very expensive. >$5000.00. Supply costs comparable to photo copiers.
Color Laser Printers Unknown as technology very new	As above two. Supports full color printing.	Very new technology with little software support. Very expensive >$12000.00. High supply costs >$.35 per sheet. Uses special paper.
Communications Devices		
Description	**Advantages**	**Disadvantages**
300 Baud modems.	Common Speed. Inexspensive. $90.00 - $ 200.00.	Slow. Old Technology.
1200 Baud Modems as above	Most common Speed. Inexpensive. $120.00 - $600.00. Generally compatible with lower speeds.	Still relatively slow.
2400 Baud Modems as above	Fast speed. Newest generally accepted speed for dial-up networks over standard telephone lines. Compatible with all slower speeds	Still limited number of usable ports. More expensive.
>2400 Baud Modems	Useful for specific appplications. Very current technology. Very Fast. Top Limit now 14.4 k bps. One use is for network bridges.	Expensive. Not commonly in use. If line quality poor, many features not useable. May drop back to 1200 or 2400 baud.
FAX Modems As above	Allows direct use of FAX by a computer. Less expensive than a real FAX approx. $1000.00.	Not useable as a normal modem. Requires a dedicated machine to function as a true FAX.
Voice Over Data Modems As above	Allows both voice and data over the same telephone line. Leading edge technology. Results in reduced line costs where data and voice communication is required.	Still some problems with functionality. More expensive than standard modems. Quality of voice portion of transmission is weak.

Computers

Video Screens

Description	Advantages	Disadvantages
Monochrome Monitors Basic Shades: Green on Black, Amber on Black, Black on White. LCD requires light to see characters on screen. Footprint - Sits on computer	Low costs. Possibly easier on the eyes. Best for word processing, business applications with limited graphics.	Not as good for graphic images. Color can attract the attention of the user easier.
Color Monitors - Standard Footprint- Sits on computer	Better for attracting attention. Superior for graphic applications.	More expensive. Can have poor resolution when used for text. Harder on the eyes.Generally bulkier.
Color Monitors - RGB Footprint - As above	Better quality images. Handles text and graphics satisfactorily.	Expensive. May require extra hardware in the computer.
High resolution RGB. Footprint - As above	Excellent quality image. Best support of both text and graphics. Many come with monochrome mode.	Expensive. May require extra hardware and memory in the computer.
Large Screen Monitors Footprint- sit beside the computer	Excellent quality. Large size, 11" by 17". Large display area. Excellent for desktop publishing and graphics work.	Very expensive >$1800.00. Currently mainly available in the Macintosh environment. Large footprint. Requires additonal extra memory. Cost->$1000.00. Overhead in speed.

Printers

Description	Advantages	Disadvantages
DaisyWheel Printers	High quality output. Low supply cost. Relatively inexpensive.	Slow. 25-45 CPS. Uses ribbons. Need attachments to use standard sheet of paper without hand feeding. No graphics ability. Old technology. Noisy.
Typewriter w/ communications	High quality output. Dual purpose machine. Low supply cost.	Extremely slow. Often small compatibilty problems. Noisy.
Dot Matrix	Acceptable text quality in high end models. Fairly high speed. Graphics ability. Can print color. Inexpensive. Low supply costs. Most common type of printer.	Poor text quality in low end models. Must purchase additional attachment to use sheets. Noisy.
Laser Printers - Non Postscript	Excellent quality text. Quiet operation. Uses standard papers. Fast printing. ~800 cps.	More expensive > $2500.00. Supply costs comparable to photo copiers. Limited graphics without additional costs.

Computers

Storage Devices

Description	Advantages	Disadvantages
5 1/4" Floppy Diskette Usually Internal	In extensive use. Portable. Least expensive diskette medium. Drives are inexpensive.	Easily damaged. Limited Storage (125k - ~1 meg. max.). Old technology. Cumbersome to handle and store.
3 1/2" Diskette	In extensive use. Portable. Relatively high storage capacity (400k to 1.6 megabytes). Protected disk surface for easier handling. Most current diskette technology.	Still susceptible to damage. Limited storage. Cumbersome and hard to handle when dealing with large amount of data.
Winchester Drives (Hard Disks) Same as Mac Footprint	Large store capacity (20 to 300 megabytes). Fast access. May allow multiple station access.	Considerably more expensive than disk drives. Vulnerable if not backed up regularly.
Tape Drives	Large Storage Capacity. Relaible and hard to damage media. Excellent backup media. Portable.	Slow. Sequential access. Not usable for interactive work.
CD ROM	Extremely Large storage capacity (400 to 1000 megabytes.) Fast access. Shared storage medium. Latest technology. Expected life of 10 years.	Only available as a read-only or write-once-read many times device. Limited amount of software in this format.
ROM Mounted internal	Fast storage. Low susceptibility to damage.	Small storage capacity. Expensive. Hardware-based. Not in common use. Not easily copied.
Cassette Tape Any cassette recorder	Inexpensive equipment required. Inexpensive medium.	Sequential access. Extremely slow. Very old technology. Somewhat cumbersome to work with.

Computers

Microcomputer CPU's

Description	Advantages	Disadvantages
Motorola 68020 based machines. Example: Apple Mac II	Fast processing time. Most current technology. Supports large memories. 32 bit processor.	Expensive >$8000.00. Little educational software.
Motorola 68000 Example: Apple Macintosh, Atari ST	Well established. Large software base. Supports large memory. 32 bit processor.	Middle cost range. Limited supply of educational software. Less widely supported than 8086 microprocessor.
Intel 80386 Example: IBM PS/2 80, Compaqu 386, and other clones too numerous to mention	Fast Processing time. Current technology. Supported by a variety of vendors. Supports large memories. 32 bit processor.	Limited supply of educational software. Expensive.
Intel 8086 Examples IBM PC, Compaq Deskpro, Epson, Radio Shack and numerous clones.	Large installed base. 16 bit processor. Most popular machine. Many manufacturers. Inexpensive. Large software selection. Reliable and easy to repair.	Relatively slow. Older technology. 8/16 bit processor.
Motorola 6502 family Examples: Apple //e, Commodore Pet, Atari 580	Large installed base. Largest range of educational software. Very inexpensive machines. Many presently in schools. Reliable and easy to repair.	Slow. Old technology.8 bit processor.
Apple 65C02 Example: Apple IIGS	Revised 6502 processor. Takes advantage of software for the 6502 Apple //e's. Faster than 6502 machines. Relatively current technology.	Mid-range in price.
Intel Z-80 Example: Osborne, Kaypro, etc.	Large installed base. Large range of software. Very inexpensive.	Out of date technology. Complex to operate. Very slow. Limited educational software. Hard to find support.

APPENDIX 2

Cost Analysis

COMMENTARY

The estimated construction cost premium for the Distance Education Suite has been based on two programme areas derived from the study material. The premiums range from \$ 910.00/m^2 to \$ 1000.00/m^2 and have been summarized as follows:

Element	**Cost/m^2 Programme Area 121 m^2**	**Cost/m^2 Programme Area 71 m^2**
Interior Partitions	32.00	29.00
Doors	18.00	31.00
Floor Finishes	125.00	125.00
Ceiling Finishes	25.00	25.00
Fittings and Fixtures	125.00	140.00
Electrical	215.00	240.00
Mechanical	370.00	420.00
TOTALS	**\$ 910.00/m^2**	**\$ 1 010.00/m^2**

SCOPE

In preparing the estimated unit costs we have included the following items:

Interior Partitions

Low partitions at workstation areas and full height partitions to private study areas or enclosed laboratory areas.

Doors

Airtight door to the Distance Education Suite and doors to the fully enclosed areas.

Floor Finishes

The increase in cost to provide a raised floor system.

Ceiling Finishes

The increase in cost to provide a fully flexible ceiling system.

Fittings and Fixtures

The additional cost for millwork, lockable storage, window blinds and items over and above normal classroom fittings.

SCOPE (continued)

Electrical

The additional cost to provide a stand alone system including main panel with isolated ground bus and feeders, U.P.S., intrusion alarm, smoke detectors and fire alarm interface, individual receptacles for each workstation with power and telephone and a master control from the teacher's area and lighting with parabolic diffusers, full spectrum lamps and alternate switching arrangements.

Mechanical

The additional cost to provide a stand alone system including electronic air filtration, heating and ventilation with air conditioning, halon fire suppression system and smoke isolation dampers and miscellaneous plumbing fixtures and outlets in the laboratory area.

APPENDIX 2 (continued)

The following pages provide a summary in support of the previous cost analysis. The most important aspect of these pages is the distinction made between the total Dollar requirement (\$1010.00/m^2) and the basic requirement (\$687.00/m^2 for items marked *). The basic requirement includes those elements of building construction that it would not be practical to *exclude* at the time when the Distance Education Suite is constructed. Other elements could be included later, as required.

BTY Ltd. Distance Education Suite April/88

*** SUMMARY**

		$/m²
4.00	Interior Partitions	60.00
6.01	Floor Finishes	125.00
6.02	Ceiling Finishes	25.00
7.00	Fittings and Fixtures	140.00
8.01	Electrical	240.00
8.02	Mechanical	420.00
		$1010.00/m²

* **Basic requirements**
$687.00/m²

4.00 Interior Partitions

				Quantity	Rate	$
*1)	Extra partitions within DES area					
		6/1.20 = 7.20				
		8.00				
		15.20 x 2.00	30.40			
			22.60	53 m^2	40.00	2120.00
*2)	Miscellaneous doors			2 No.	600.00	1200.00
*3)	Air-tight entrance door			1 No.		980.00
						$4300.00
						71 m^2
						$60.00/$m^2$

*** $60.00/$m^2$**

*** Cost Factors**

			Quantity	Rate	$/m^2
*3)	Flooring (Pedestal)				
	allow	$50.00 (25.00)			$125.00
*4)	Ceiling (upgrade on traditional) (T-bar ceiling)				
	allow	$45.00 (20.00)			$25.00

*** $125.00/m^2**

*** $25.00/m^2**

BTY Ltd. Distance Education Suite April/88

*** Cost Factors/F & E**

		Quantity	Rate	$
*5)	Lockable storage	2 No	800.00	1600.00
*6)	Miscellaneous benches etc. 6/2.50	10m	600.00	6000.00
*7)	Whiteboards (premium)	Allow sum		1000.00
8)	Blinds 2/3.00 x 1.50	$9m^2$	70.00	630.00
9)	Miscellaneous Lighting	Allow sum		770.00
				$10000.00
				$71m^2$
	*** $121.00/m^2$**			$140.00m^2

BTY Ltd. Distance Education Suite April/88

*** Cost Factors**

Electrical (6 stations)	**Quantity**	**Rate**	**$**
*Electrical motor control @ A/C unit			800.00
*UPS - 5kVA with feeders			1100.00
*Intrusion alarm (per door)			500.00
Fire alarm interface			600.00
Smoke detectors	5.15		365.00
*Outlets (per workstation)			
•Telephone	35.00		210.00
•Power	68.00		288.00
•Isolated power	55.00		330.00
*Wall mounted raceways			1200.00
*Main power panel with isolated grand bus & feeders			2300.00
*Laboratory (experience area) power			400.00
Master control switching (per stn.)		670.00	4020.00
*Telephone main feed to electrical room			2500.00
*Parabolic diffusers (per stn.)	80.00		480.00
*Stepped full spectrum fluorescents (per stn.) $88.00 $105.00	193.00		1158.00
Task lighting & switching (per stn.)	130.00		780.00 (31)
			$17000.00
			71 m^2
*** $159.00/$m^2$**			$240.00/$m^2$

BTY Ltd. Distance Education Suite April/88

Mechanical

		Quantity	Rate	$
*Electronic air filtration based on 1000 cfm		$1.20 per cfm		1000.00
Separate heat & vent system independent from the main building	- equipment	$3.25 per cfm		3000.00
	- distribution	$4.00		
		$(\$43.00/\mathrm{m}^2)$		3000.00
*Air conditioning	- packaged A/C unit approx. 5 to 8 tons	$2000.00 per ton		8000.00
Fire protection		$(\$105/\mathrm{m}^2)$		7500.00
	- halon system	$\$1.00\ \mathrm{ft}^3$		
	- smoke isolation (ventilation)	$1500.00		1500.00
Laboratory area				
*(incl. 1 fixture/lab)	- plumbing (approx. 10 No. gas & water outlets)			3000.00
	- ventilation (exhaust requirement)			2000.00
Control monitoring		$1000.00		1000.00
				(300)
*** $\$197.00/\mathrm{m}^2$**				**$30000.00**
				$\$420.00/\mathrm{m}^2$

N.L.C. - B.N.C.
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